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ESTIMATING STAFFING AND COST FACTORS FOR SMALL WASTEWATER TREATMENT PLANTS LESS THAN 1 MGD

PART I. STAFFING GUIDELINES FOR CONVENTIONAL MUNICIPAL WASTEWATER TREATMENT PLANTS LESS THAN 1 MGD

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This study is one of many which has as its primary objective improved wastewater treatment. In the area of water pollution control, proper wastewater treatment is one such control measure. One mechanism for good control is to insure that new and existing treatment plants are operated by adequate numbers of well-trained staff. This report describes the objectives, manpower planning, and management for treatment plants

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1. INTRODUCTION

The treatment of wastewater is vital to our survival. Little needs to be said regarding the importance today of its effective treatment to prevent the pollution of our water resources, our streams, rivers, and lakes; the water we drink.

This study is one of many which has as its primary objective improved wastewater treatment. To meet the current concern for preservation of environmental quality, many factors contingent to the problem must be examined. Some factors are readily recognizable and highly popularized as faults that degrade our surroundings while others are more obscure and do not capture public attention.

The steps which must be taken to correct and control many of the problems are fundamental. Analytical and technical knowledge needed to develop control measures is already available and requires only the proper authorization and support to be implemented. In the area of water pollution control, proper wastewater treatment is one such control measure. One mechanism for good control is to insure that new and existing treatment plants are operated by adequate numbers of well-trained staff.

The 1970 Federal Water Pollution Control Act, and the Amendment of 1972 in support of activities to assist in the proper operation of waste treatment facilities, provides a significant opportunity to develop adequate training programs in waste treatment plant design and operation. However, the programs are disadvantaged by a lack of information regarding both "task" and "cost" factors. Task factors are defined as specific work elements which must be performed for proper

operation of the plant and the estimates of time necessary to accomplish these tasks. Without this information, estimates of the true costs of operation and maintenance are inadequate and unrealistic. Development of operating planning factors to determine current manpower needs and training requirements, based on adequate knowledge of tasks and costs, can provide benefits to communities operating treatment facilities in cost control. But more importantly, these factors provide benefits in the maintaining of high quality treatment systems. Information regarding task factors forms the basis for manpower planning guidelines. In other words, identifying crew size requirements, job specifications, and job definitions is a function of descriptive parameters of the size and type of plant. Specific benefits which accrue from the development of guidelines for manpower planning are bases on which to provide:

1. Design of man-machine systems
2. Orientation of work space
3. Design of work space environment control
4. Development of career structures
5. Identification of tasks required for optimal operation
6. Specifications of manpower requirement
7. Establishment of manpower selection standards
8. Identification of training requirements
9. Development of aids in job performance
10. Evaluation of work performance

Detailed knowledge of requirements in each of the above areas would assist in maintaining a water pollution control development program designed to provide a desired, high environmental quality standard.

Through study results already reported to EPA, task analyses, job profiles, and many other facets of operating a conventional wastewater treatment plant have been identified. These studies, however, have so far referred to high volume treatment plants [daily capacities over 1 million gallons per day (MGD)] and do not necessarily apply to the operation of smaller volume plants (capacities of 999,999 gallons per day and less). In many areas of the United States, custom design of small, municipal, conventional plants is widespread. In this small-plant category, over 200 were found in Iowa – the primary source of data for this study. Thus, there is a very real and growing need for the acquisition of operation and maintenance information which can be used to provide realistic estimates of manpower needs and training requirements for the small wastewater treatment plant.

1.1 Study Objectives

To meet the above stated needs, this study proposed:

> To develop occupation descriptions and specifications for conventional waste treatment facilities having an average design flow of 0-1 MGD and to provide time requirement estimates for job tasks in such a manner as to provide bases for staff planning and hiring guides, training programs, and operating procedure recommendations.

1.2 Study Techniques

For the purpose of providing information on manpower needs and training requirements for municipal treatment plants, data was collected from a sample of facilities varying in average design flow up to 1 MGD. The method of sample selection was based on initial surveys of facility

sizes and locations for each category and size represented. A sequential sampling was employed in the sense that the initial sample size was increased depending on the availability and variability of the data initially obtained.

Treatment plants operating in Iowa and the immediately surrounding states were considered representative of the population of such facilities in the United States.

The facilities included in this study can be classified into three basic types:

Type 1: Primary sedimentation with separate sludge digestion followed by a trickling filter and final sedimentation tanks

Type 2: Imhoff tanks incorporating sedimentation and sludge digestion in a single unit followed by a trickling filter and final sedimentation tanks

Type 3: Completely mixed activated sludge system without primary sedimentation.

Since the plants in the 0-1 MGD range are frequently operated with part-time labor in the lower ranges and up to three or more in the upper ranges, the data was separated into five size classifications of 200,000 gallons per day average design flow. Table I-1 summarizes statistical data from 138 plants included in this study.

The visitations to the various plant sites afforded an excellent opportunity to observe conditions which normally are not evident from pure statistical tabulations of data. While these observations do not lend themselves to hard and fast recommendations, the study would be incomplete without including this element as background material.

Table I-1. Summary statistics from 138 plants studied.

Class		Reported man-hr/ week	Reported No. employed	Total No. of plants	Avg employed/ plant	Avg man-hr/ wk/plant
I	Primary sedimentation[a]	452	26	15	1.73	30.1
0.0-0.2 MGD	Imhoff tank[b]	596	44	30	1.46	19.8
——→	Activated sludge[c]	259	17	16	1.06	16.1
	Composite	1307	87	61	1.42	21.4
II	Primary sedimentation	786	34	17	2.00	46.2
0.2-0.4 MGD	Inhoff tank	180	9	6	1.50	30.0
——→	Activated sludge	38	3	2	1.50	19.0
	Composite	1004	46	25	1.84	40.1
III	Primary sedimentation	995	31	18	1.71	55.2
0.4-0.6 MGD	Imhoff tank	20	1	1	1.00	20.0
——→	Activated sludge	184	4	3	1.33	61.3
	Composite	1199	36	22	1.63	54.5

Table I-1. Continued.

Class		Reported man-hr/ week	Reported No. employed	Total No. of plants	Avg employed/ plant	Avg man-hr/ wk/plant
IV	Primary sedimentation	360	22	7	3.13	51.4
0.6-0.8 MGD	Imhoff tank					
——→	Activated sludge	311	8	3	2.66	103.6
	Composite	671	30	10	3.00	67.1
V	Primary sedimentation	1093	34	17	2.00	64.3
0.8-0.1 MGD	Imhoff tank					
——→	Activated sludge	162	10	3	3.33	54.0
	Composite	1255	44	20	2.20	62.7

[a]Type 1: Trickling filter preceded by primary settling tank.

[b]Type 2: Trickling filter preceded by Imhoff tank.

[c]Type 3: Completely mixed activated sludge, no primary settling.

1.3 Conclusions Based on Field Studies

1. It appears that with more uniform and controlled testing requirements the plants would conceivably be operated at a more uniformly high level. This would tend to occur through inspection pressures as well as supervised maintenance of minimum standards. In an attempt to identify the current status of reporting requirements across the United States, information was obtained from 35 states. The diversity found in the operating requirements, enforcement policies, and inspection standards was extreme.
2. Unless local authorities are motivated to provide adequate manpower and funds for proper operation of the treatment plant regardless of where the initial funding originates, the plant is not going to operate effectively. This includes providing adequate man hours, operating supplies, equipment, wages and related support. A peculiar problem to the small plant is that priorities are attached to other duties in the community. Operators in the small plant may be strictly part time with this responsibility shared with street repair, park mowing, solid waste problems, and law enforcement.
3. The operation of the small treatment plant is greatly affected by the motivation and training of the individual operator. This training must include knowledge of basic processes, how to operate properly the plant equipment, how to recognize potential trouble, how to diagnose and make temporary repairs, and where to obtain additional assistance if it is needed. Thus the training must encompass what the process is and does, how to control it, when to take corrective action, and where to obtain competent aid in time of stress.

4. The 1972 Amendment to the Water Pollution Control Act provides a vehicle for area wide planning and management in areas which have substantial water quality control problems. Research should be encouraged to establish quality control measures and guidelines which can identify the problem areas and thereby facilitate the implementation of the provisions of the Act as amended.

1.4 Precautionary Note for the User

Information obtained and resulting in the descriptions, specifications, and time requirements herein included should be used with other localized information (when available) relating to individual motivation and implementation. Further, the guidelines resulting from this study must be regarded as first steps. As conditions change, operating standards become more uniform and stringent, performance tends to become more consistent and important, and technology provides additional operational improvement. The descriptions, specifications, and time requirements must change to more precisely reflect conditions. A mail survey was made of all 50 states to determine the universality of the time requirements after the completion of the field work.

The results did not refute the conclusion made in this study, but the results obtained in the survey were inconclusive relative to the responses provided. It would appear that the approach taken in this study, i.e., on site investigation by trained field personnel, provide greatly improved reliability over other presently available data.

The reader may wish to turn directly to 2.1, p. I-45 for application of the guidelines provided in this study.

1.5 Modular Approach to Manpower Planning

The occupations necessary to wastewater plant operation are composed of various jobs which are identified by particular task groupings necessary to the completion of the occupation objective. For example, a plant which is operated by one individual will require an occupation description which identifies that objective. Further, the occupation description will be composed of jobs which indicate the operation and/or maintenance of an individual unit process such as a primary sedimentation system, or a trickling filter. Unit processes are made up of specific tasks which describe the sequence of activities which must be performed such as flow adjustment, equipment inspection, scum removal, housekeeping, etc.

Plants which are in operation or under design and construction vary in type, or the unit processes involved, for many reasons including quality of influent, geography, climatic conditions, magnitude of flow, and design philosophy. Once designed, a facility defines the unit processes involved and the tasks required. The frequency of performance of these tasks and the length of time per performance is largely determined by the quantity and quality of the influent. The skills and knowledge requirements for the performance of these tasks is determined by the complexity of the task, the tools and equipment involved, and the degree to which improper performance can cause loss of quality, impair treatment, or create unsafe conditions.

A modular approach indicates that each task is examined, measured, and described so that the tasks become building blocks. Each task can be identified as to time requirement and skill and knowledge requirement. As such the task is independent and a plant profile, within the range

of facilities for which the tasks are defined, can be synthesized by putting together the appropriate building blocks.

Figure I-1 illustrates the concept of determining the time requirements for various occupation levels given the technological profile, in terms of the unit processes and tasks, of any particular plant. Use of this modular approach enables the resulting guideline factors to be "tailored" to a specific plant and avoids a rigid standardization of the results which may not readily apply to any "real" plant.

1.6 Importance and Use of Occupation Descriptions and Specifications in Manpower Planning

Data derived from the disciplines of industrial engineering and industrial psychology can be used extensively in manpower planning for water pollution control. Industrial engineering brings to human engineering the knowledge of equipment layout, work flow, job/task time requirements, and safe use of plant facilities. Industrial psychology makes its contribution in the area of testing, selection, placement, training, counseling, and evaluation of workers. Both disciplines are concerned with developing and implementing programs to promote efficient manpower utilization.

Therefore, our purpose here is to

1. Give the manpower planner a capability to apply manpower planning criteria
2. Provide a means for understanding the disciplines, methods, and concepts applied to develop the criteria
3. Provide a means for understanding how the methods and concepts of human engineers – industrial engineers and industrial psychologists – can be applied to overcome problems and improve practices related to manpower recruitment, utilization, and retention.

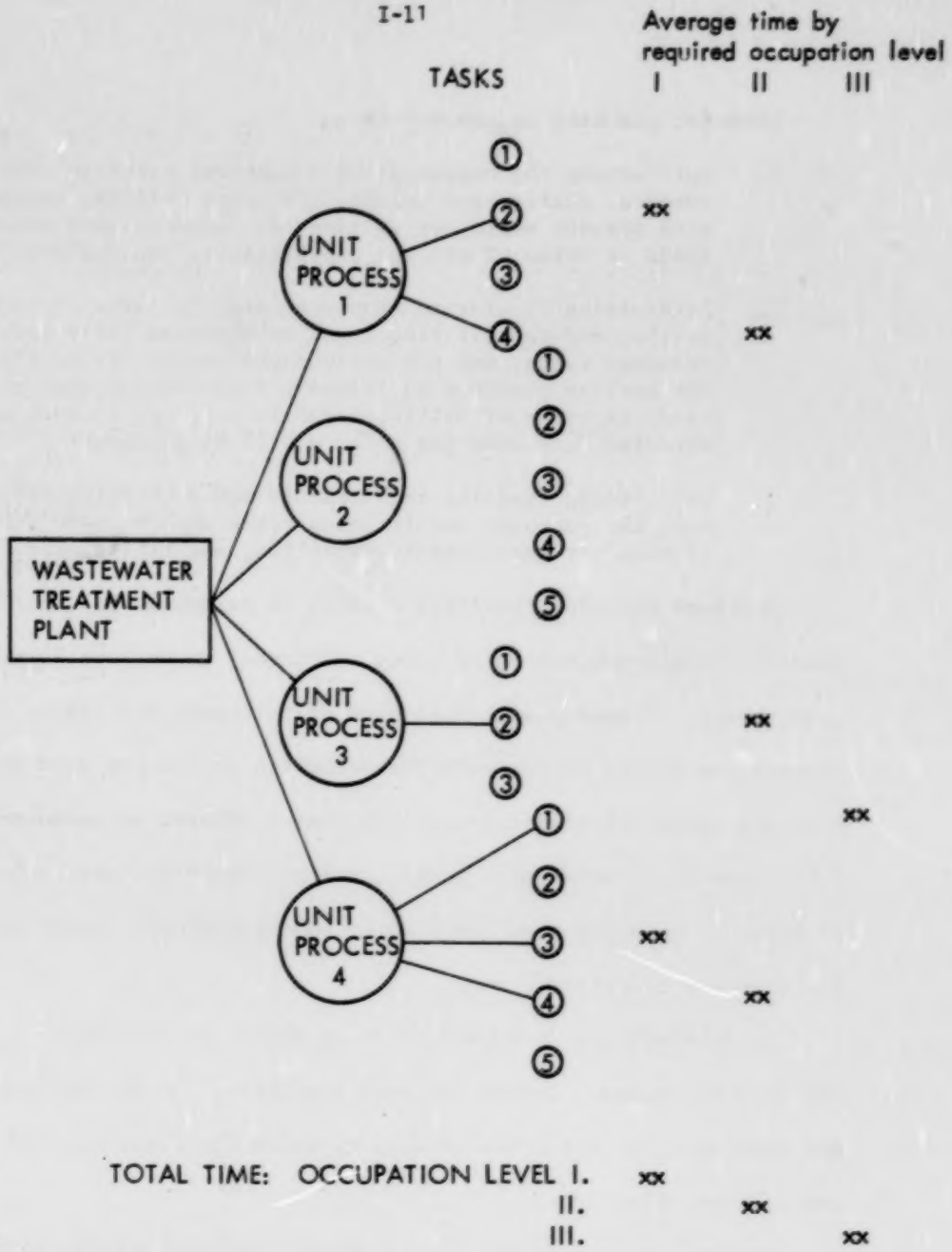

Fig. I-1. Modular approach to manpower planning.

Manpower planning is vital to the successful operation and maintenance of wastewater treatment plants. Therefore, it is necessary to understand what is implied when we discuss manpower planning.

Manpower planning is the act of

1. Determining the organization's manpower needs in terms of numbers, skills, and capabilities, and matching these needs with present employees to identify current human resource needs in terms of skills, capabilities, and numbers

2. Determining the future manpower needs in terms of numbers, skills, and capabilities based on expected retirement rates, turnover rates, and the anticipated growth (or decline) of the service provided to identify future human resource needs in terms of skills, capabilities, and numbers with the expected date when these needs will be paramount

3. Determining training requirements and developing programs to meet the manpower and training needs and overcome problems of manpower recruitment, retention, and utilization.

Manpower planning therefore results in personnel policies and practices which support the filling of current as well as future manpower needs. Planning will also have an influence and effect on the present and future recruitment and selection procedures used and on the type and amount of training and development offered to personnel. The establishment of employment goals, training programs, and budget needs is based on manpower planning done by administrators, design engineers, state agency inspectors, etc.

In developing a "manpower staffing plan," we must first analyze the current system. System analysis identifies the system objectives and evaluates the different strategies which are available for achievement of the objectives.

System analysis is the act of studying a total system to identify and evaluate:

1. All inputs into the system, such as personnel, raw materials, equipment, etc.

2. The actions and transformation activities being performed by personnel and physical facilities on other system inputs to achieve system objectives, and the time and frequency performance associated with these actions

3. The interrelationships between the different actions and activities

4. The outputs of the system as compared to desired objectives

5. The alternative actions and activities available for achieving system objectives.

The result of a complete system analysis will be, among other things, the identification of those treatment activities being performed by the present facilities, the "work tasks" which need to be performed by the plant personnel in providing these treatment activities, and the time required to perform these tasks.

The planners for each treatment plant must accomplish the above, either superficially or after great study and thought. In either case, some guidelines for determining job assignments with their job descriptions and specifications would be helpful.

To aid the planners in this analysis, a "conceptual model," such as that shown in Fig. I-2, is provided to show pictorially the dynamic characteristics of work relationships and those variables which influence the effectiveness of human effort at work and their relationships. Variables that are discussed are represented by a circle, while a rectangle identifies those variables which influence or are influenced by the variables studied. For identification purposes, each variable is represented by a number (1 through 15). The arrows indicate direction of influence; thus: A → B means A influences B.

1.6.1 System Effectiveness

We are primarily concerned with increasing the effectiveness of wastewater treatment. "System effectiveness" (variable 1) represents the extent to which the system produces an effluent which is socially

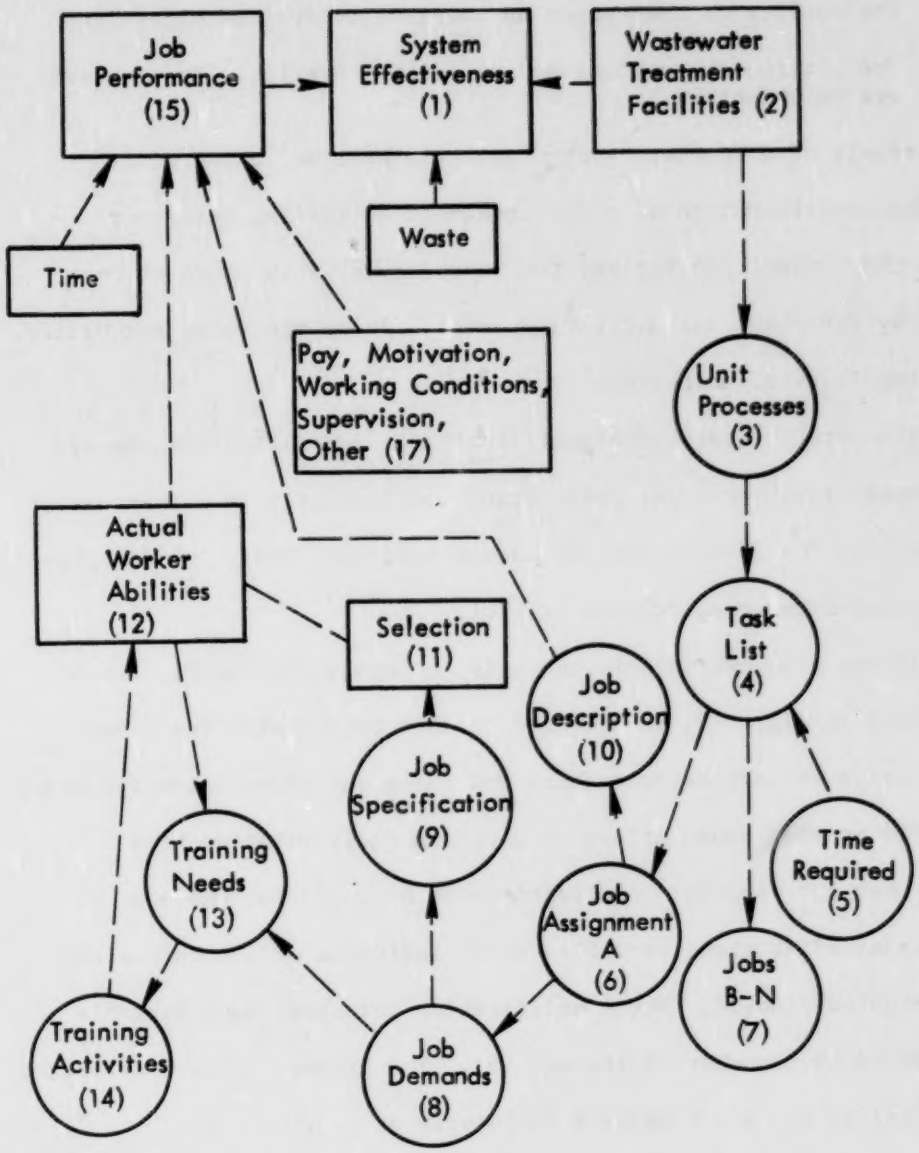

Fig. I-2. Dynamic characteristics of work relationships and variables (1 through 15) which influence the effectiveness of human effort.

acceptable. "System effectiveness" is influenced by three major variables: 1) the waste or influent being treated, 2) the present wastewater treatment facilities (variable 2), and 3) the job performance by the employees (variable 15) (Fig. I-3).

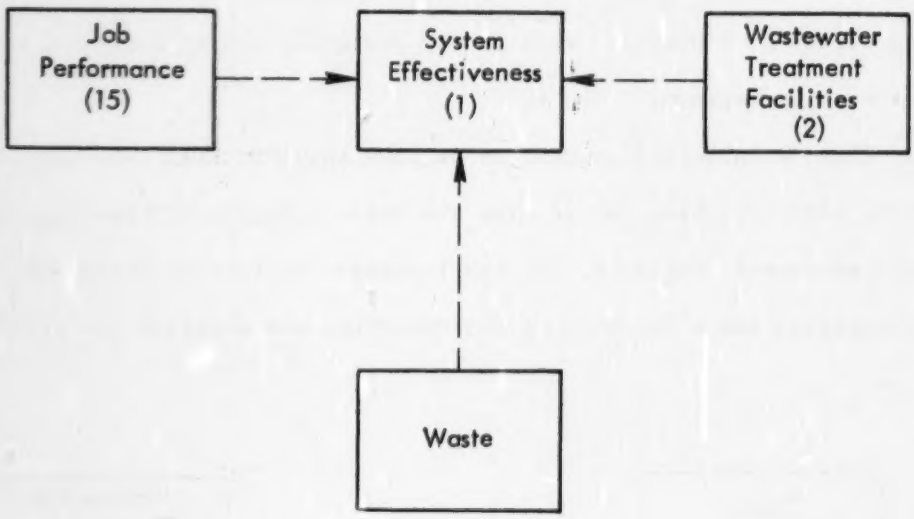

Fig. I-3. Influence of job performance, wastewater treatment facilities and waste on system effectiveness.

Another way of representing this relationship is to state the following expression:

System effectiveness = f(JP, WF, W, O)

where JP = job performance

WF = wastewater treatment facilities

W = waste input

O = other variables.

In our model, the "other variables" are not identified and are assumed to be relatively insignificant.

1.6.2 Wastewater Treatment Facilities

"Wastewater treatment facilities" (variable 2) represents the current and given physical facilities at a treatment location. These facilities might be new, old, or middle aged; well maintained or in some degree of disrepair; excellently designed, poorly designed, or somewhere in between.

This variable influences, as we have shown in Fig. I-4, the total system effectiveness. It is also the major variable influencing the "unit processes" variable, for the treatment activities performed at any location are a function of the condition and state of the physical

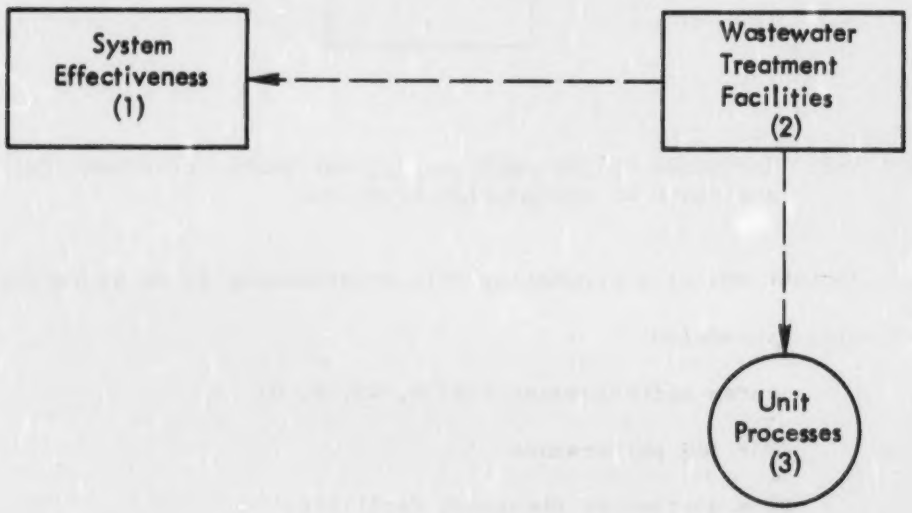

Fig. I-4. Influence of physical facilities on total system effectiveness.

resources, the "wastewater treatment facilities." This can be represented by:

Unit processes = f(WF)

where WF = the wastewater treatment facilities.

1.6.3 Unit Processes

"Unit processes" (variable 3) identifies the different treatment functions. Each unit process or function accomplishes a specified end result which contributes to the total wastewater treatment objective. As an example, one unit process might be identified as grit removal. This process references those plant facilities specifically designed to remove grit from the influent.

Another way of viewing the unit process variable is to see it as representing a way of classifying or categorizing portions of the wastewater treatment facilities according to their function. The unit processes influence the work tasks which must be performed by the human resource as the operation and maintenance function of the wastewater treatment facility (Fig. I-5).

1.6.4 Task List

For the purposes of this manual, a work task is defined as

> ... an action or action sequence grouped through time (and) designed to contribute a specified end result to the accomplishment of an objective and for which functional levels and orientation can be reliably assigned. The task action or action sequence may be primarily physical, such as operating an electric typewriter; or primarily mental, such as analyzing data; and/or primarily interpersonal, such as consulting with another person.

Work tasks are performed by human resources in conjunction with the physical facilities as the specified treatment activity is accomplished.

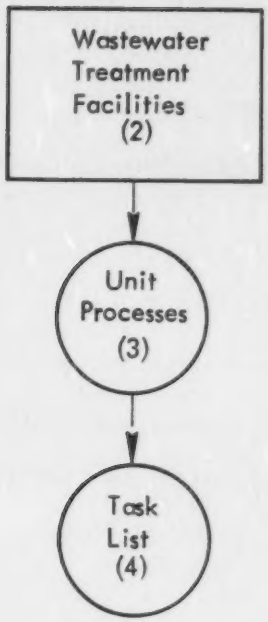

Fig. I-5. Influence of wastewater treatment facilities and unit processes on the task list.

Only by the introduction of the human element do the wastewater treatment plant facilities and their resulting treatment activities become operational. The effective operation of the physical facilities requires that certain functions be performed by the human resource input. The "task list" (variable 4) therefore represents the variety of different work tasks which are associated with wastewater treatment. Work tasks will vary in their complexity and in their demands upon the employee.

"Task lists" are a function of the "treatment activities" performed and are basic building blocks in determining specific job assignments (Fig. I-6).

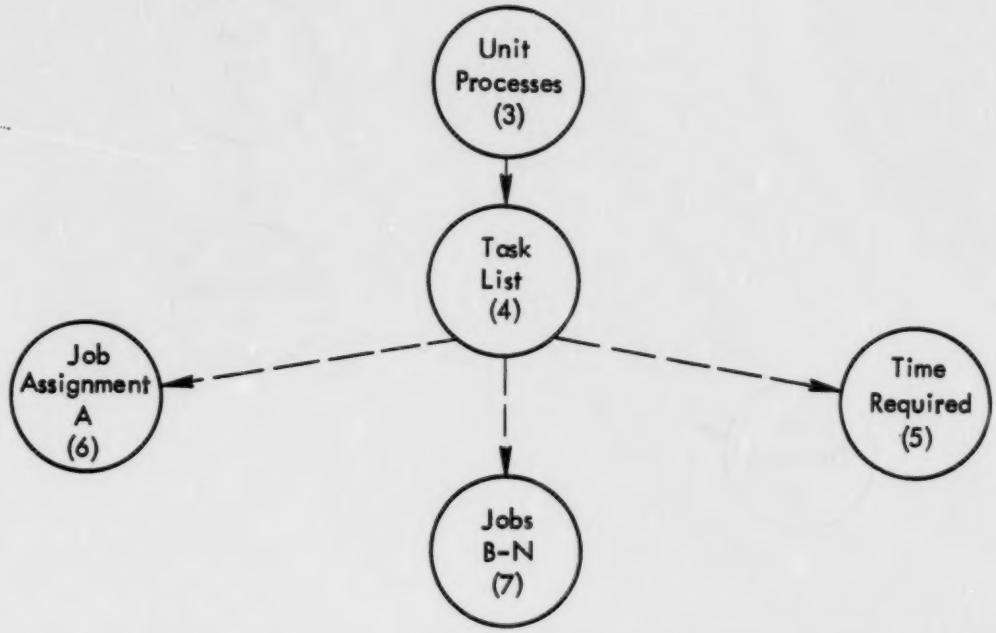

Fig. I-6. Basic building blocks for specific job assignments.

1.6.4.1 Time Task Requirement

Each task is measured in terms of the time which the performance of that task should be expected to require.

1.6.4.2 Job Assignments

Job design is the act of determining which specific "work tasks" will be grouped together and considered as a work unit for assignment to one individual. The resulting group of "work tasks" assigned to one employee is considered a work job assignment (Fig. I-7). This may be represented by:

Job assignment A = selected "work tasks"

Each "work task" requires an action or behavior on the part of the employee which takes time and places various "demands" on the individual. The normal approach to job design is to group "work tasks" such that the

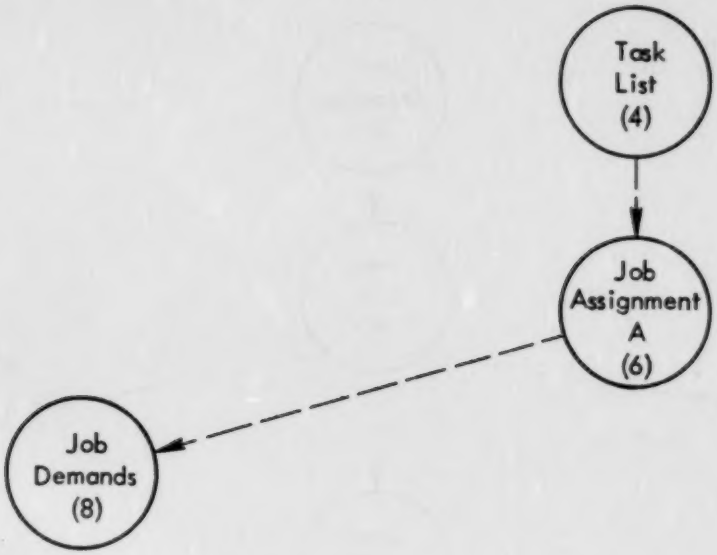

Fig. I-7. Components of the job assignment.

time demand upon the individual for the total job represents the time the individual is hired to work. Normally this represents an eight-hour workday.

1.6.4.3 Job Demands

The "work tasks" are also combined, where possible, so that demands on the individual by the various work tasks are similar. That is, either all the work tasks place minimal demands on the individual, or the majority of the work tasks place considerable, yet comparable demands on the individual. "Job demands" (variable 8) therefore is influenced by the job assignment and the work tasks associated with that assignment. The "job demands" variable represents the abilities, personal traits, and individual characteristics required of the employee to adequately perform the job assignment.

1.6.4.4 Job Specifications

Once the "job assignment" has been determined and the resulting "job demands" identified, the "job description" and the "job specification" can be written (Fig. I-8).

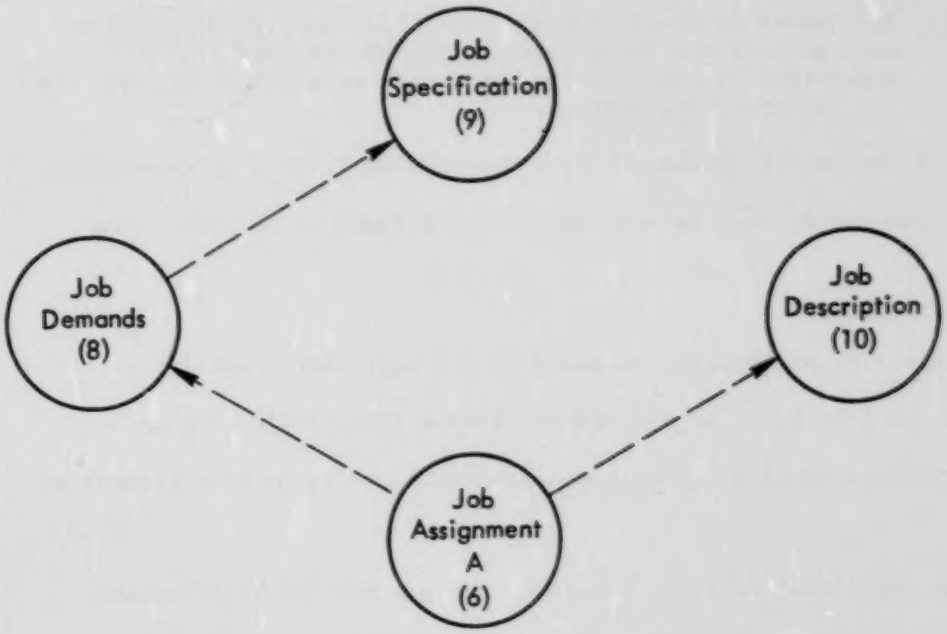

Fig. I-8. Influences on the job specification and description.

Job specifications identify and summarize the trait components for the specific job. They are used in determining the wage/salary level of the position and in the selection procedure as a basis for screening applicants and identifying the individual to be selected for specific job openings. The job specification therefore is a very important statement and needs to be carefully written.

1.6.4.5 Job Description

The "job description" is a statement in rather general terms about the "tasks" which comprise the job being described. It includes a description of

1. What actions or work tasks are to be performed by the worker
2. What accomplishments are expected by these actions or work tasks
3. The tools or equipment the worker is expected to use or operate
4. The degree of discretion the job holder has in determining when actions are to be taken (i.e., whether actions are prescribed by others or by equipment, or whether they are the discretion of the worker).

The job's design influences the "job description." It also determines, as has been noted, what demands the job will place on the individual.

1.6.5 Selection

The selection decision is based on the applicant's ability to perform the job, based on job specifications (Fig. I-9). Typically an entry-level examination is administered to assist in this determination.

The individual selected brings to the job and the organization specific capabilities and capacities (variable 12). It will be unusual if the employee selected brings to the organization the necessary requisites to fulfill the job demands immediately. In all probability, the job's demands will exceed in some manner the capabilities of the employee when employed, and the employee's deficiencies must then be reduced through a training program.

1.6.6 Training

Training needs (variable 13) are thus a function of the "task list," job demands, job description (variable 10), and the employee's capabilities at any point in time (variable 12). Training needs, once identified, should then lead to specific training activities (variable 14).

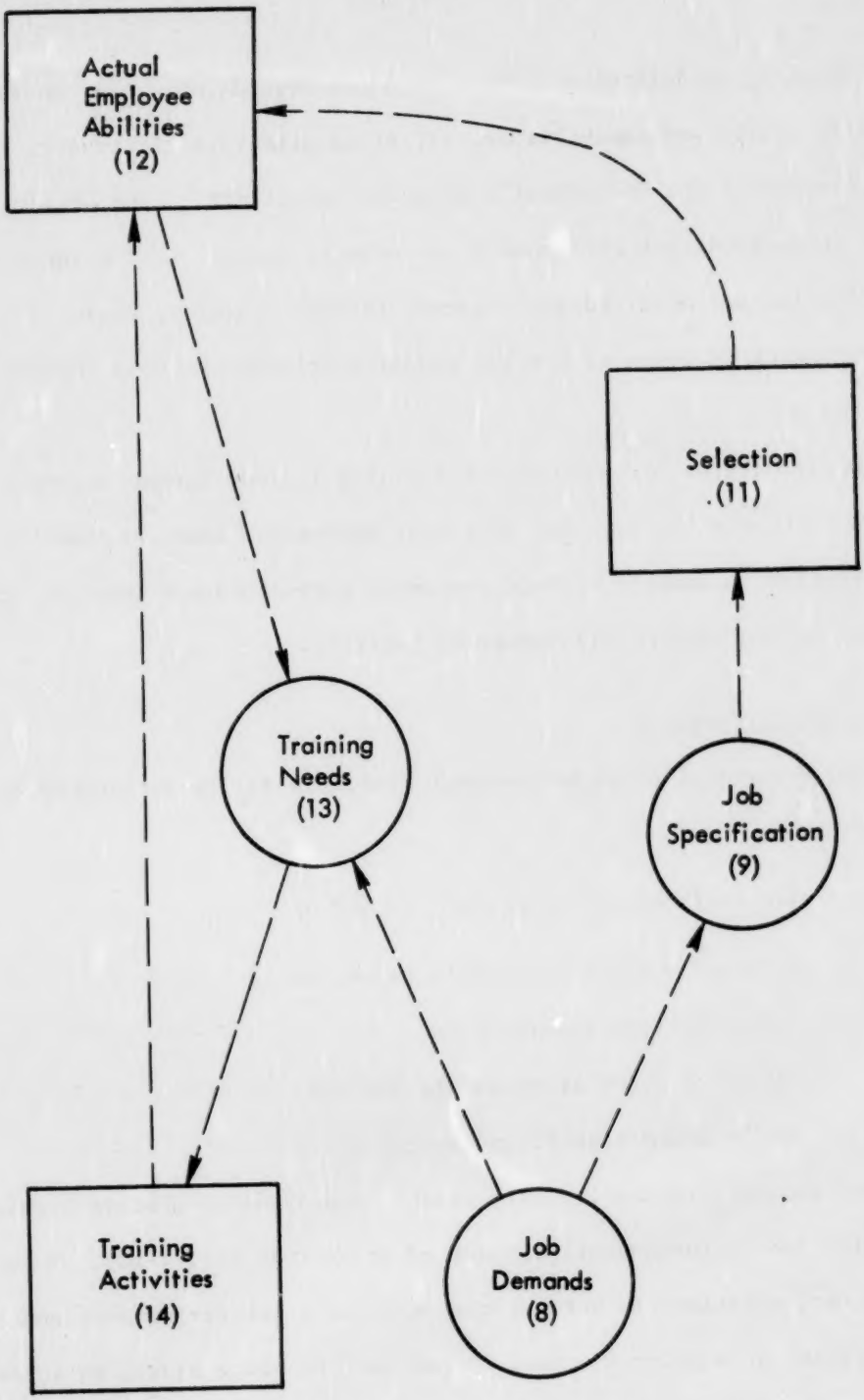

Fig. I-9. Selections based on job specifications.

Training is defined as effort directed toward increasing an individual's skills and capabilities. If it is effective, it results in modification of the individual's behavior capabilities, and hopefully leads to improved job performance and effectiveness. As the individual's capabilities are modified and changed, through training, there is a corresponding revision of the individual's deficiencies and thereby the training needs.

Opportunities for appropriate training include formal academic programs (leading to two- and four-year degrees), "short courses" on university or community college campuses, correspondence courses, and on-the-job training in the operating facility.

1.6.7 Job Performance

The individual's job performance (variable 15) is influenced by the following:

Job performance = f(EC, JD, TA and OF)

where (EC) = the given employee's capabilities

(JD) = the job's description

(TA) = the time allocated to the job

(OF) = other significant factors

The need for well-trained, highly capable employees to achieve highly effective job performance is without question (see Fig. I-10). There is a direct relationship between the employee's job performance and his capabilities at a point in time. Other factors being equal, an increase in the employee's job capabilities will increase the possibility for improved job performance.

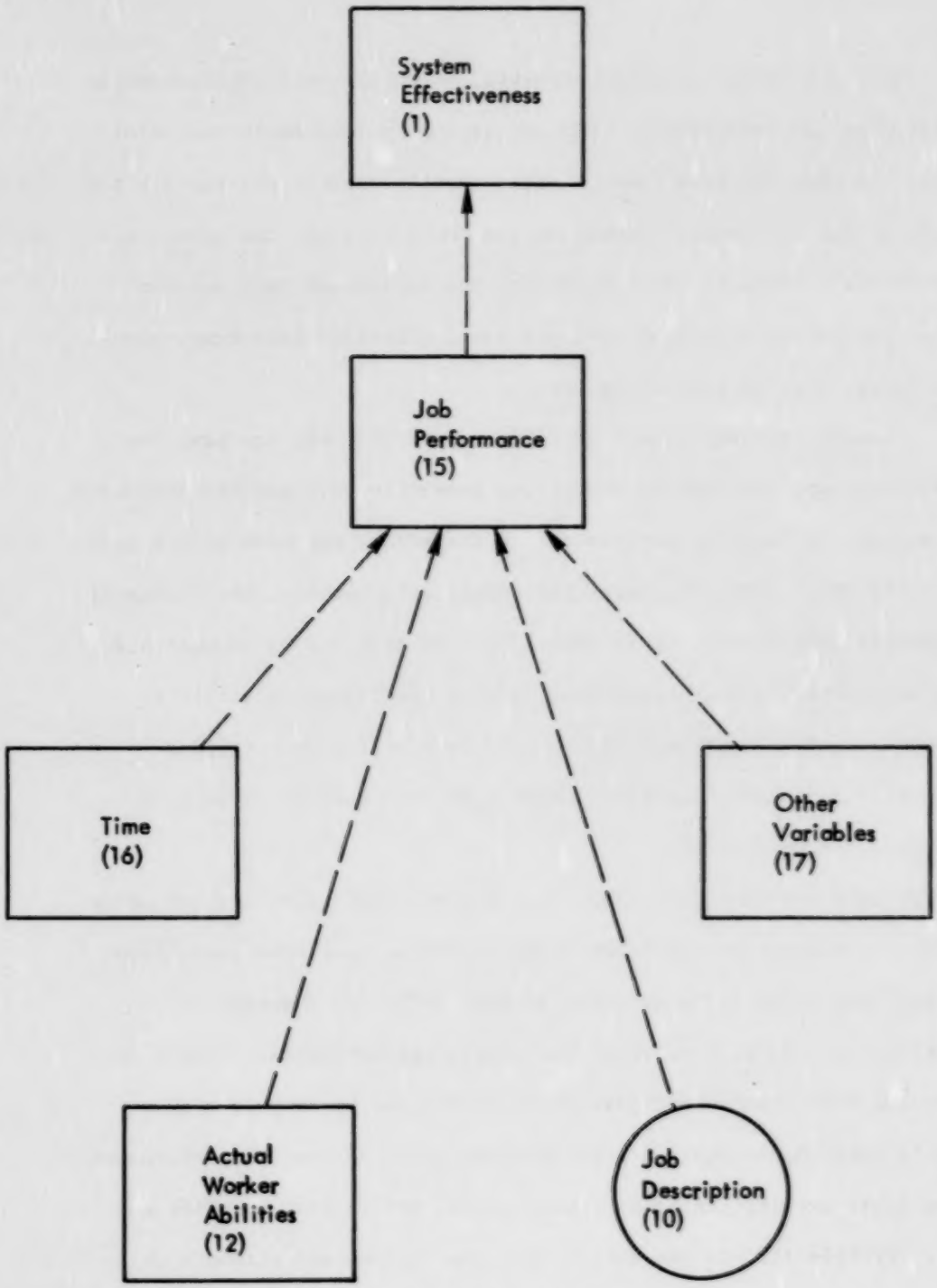

Fig. I-10. Bases of job performance.

There are other variables, however, which are most significant in influencing job performance. One is the time allocated to the total job or the specific work tasks. Given equally capable individuals and identical job assignments requiring six hours of time, the worker allocated eight hours of time to perform the assignment will achieve better job performance than the individual allocated less time, say four hours, for the same assignment.

Likewise, the employee's attitude toward the job, its pay, the supervisor, and the working conditions generally will greatly influence the employee's level of motivation and the effort expended on the job (variable 16). While the cause and effect relationships are difficult to identify positively, it is generally true that low or inequitable pay, poor supervision, undesirable working conditions, scarcity of resources, and lack of recognition will each influence attitudes negatively and reduce levels of motivation, and thereby cause less effective job performance.

We have now come full circle ... for the importance and influence of job performance on the plant's effectiveness have been recognized. The complete model is again given in Fig. I-11. To complete our conceptual model, we have added two additional variables. First, we recognize that plant effectiveness is determined by comparing the plant's performance against predetermined goals or desired performance. These goals are influenced by local, state, and federal agencies and are a variable (18) to the extent that one desires and attempts to achieve higher quality affluent. A "goals" variable has, therefore, been added to the model.

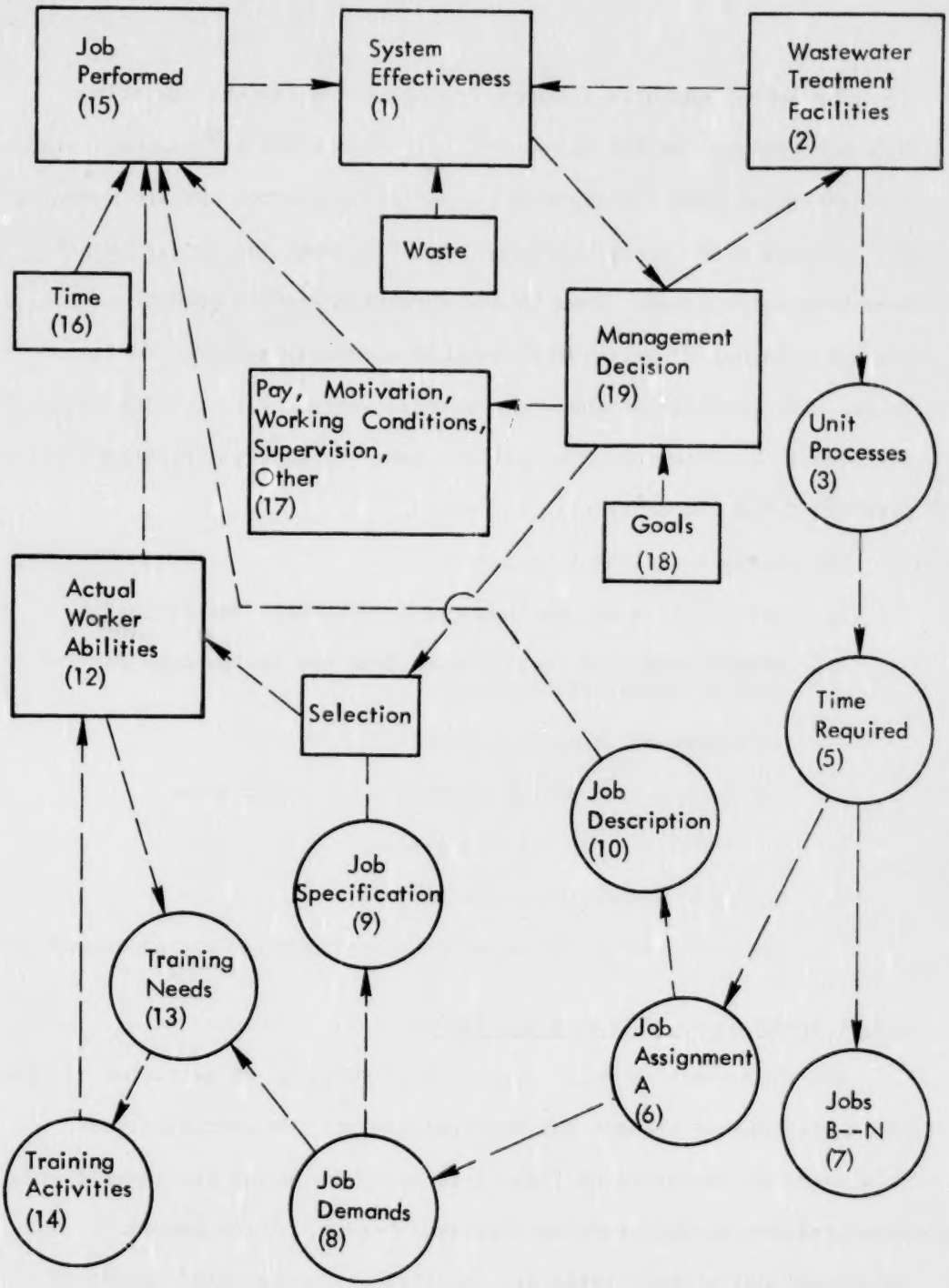

Fig. I-11. Dynamic characteristics of work relationships and variables (1 through 19) which influence the effectiveness of human effort.

The second variable is now a "management decision" variable. This recognizes that the "managers" of each wastewater treatment plant, in conjunction with the state water pollution control program manager, will compare each "plant's effectiveness" against the "goals" which have been established. When "plant effectiveness" is below the "goal," the plant "manager" will determine what action is required to improve "plant effectiveness." The state program manager will provide direction and support as required. The actions taken to improve "plant effectiveness" in these instances will be varied.

The possible decisions include:

1. Modification of the "wastewater treatment facilities"
2. Rearrangement of "work tasks" into job assignments for increased worker utilization
3. Increased training activities
4. Allocation of increased time for job performance
5. Increased pay for job assignments
6. Improved worker selection techniques
7. Improved use of the human resources through better supervision.

1.6.8 Development of Planning Criteria

The flow chart shown in Fig. I-12 provides an illustration of the steps required to prepare job descriptions and job specifications. This chart is supported by Figs. I-13 and I-14, which provide pictorial illustrations of the steps as discussed herein. Three new terms, "occupational definition" (step 8), "qualifications profile" (step 10), and "staffing guide" (step 11) have been introduced.

Step	
1	Determine total treatment activities to be accomplished. (See A, Fig. I-14.)
2	Describe the tasks within each treatment activity. (See B, Fig. I-14.)
3	Estimate the time required to perform each task.
4	Group tasks according to general task categories. (See C, Fig. I-14.)
5	Evaluate groups in terms of kind of work performed and technology. (See B and C, Fig. I-14.)
6	Determine if cumulative totals of estimates of workday time for the tasks in tentative groups will justify full-time jobs. (See Table I-5.)
7	Evaluate and adjust groups until most feasible practical arrangements of tasks are developed.
8	Prepare occupational definition. (See D and E, Fig. I-15.)
9	Determine job demands (general). (See F, Fig. I-15.)
10	Prepare qualifications profile. (See G, Fig. I-15.)
11	Formulate staffing guide.
12	Determine certification requirements.
13	Determine job assignments.
14	Prepare detailed job descriptions.
15	Determine job demands (specific).
16	Prepare job specifications.

Fig. I-12. Flow chart for the preparation of job descriptions and job specifications.

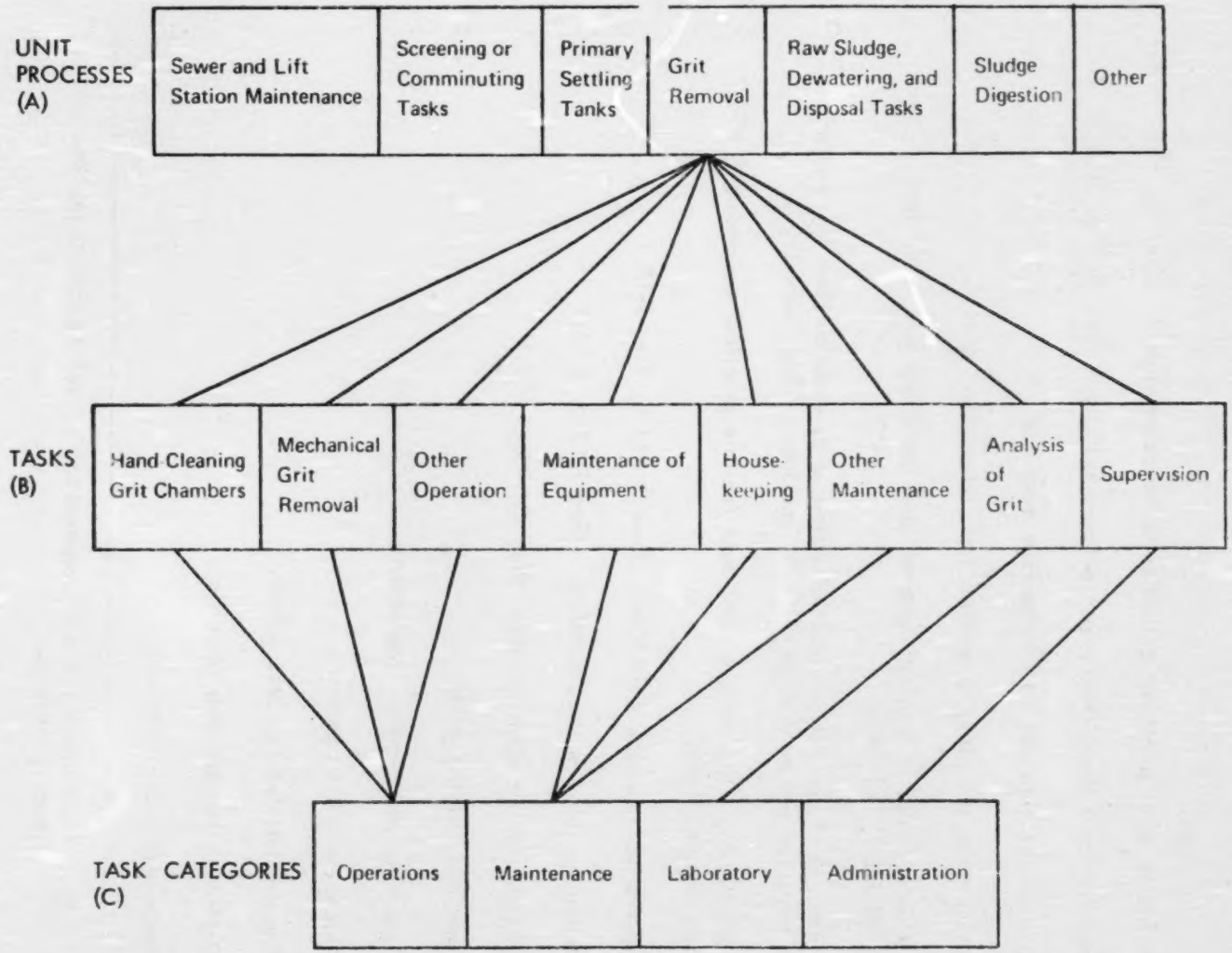

Fig. I-13. Steps required to perform a specific job (worker function scale).

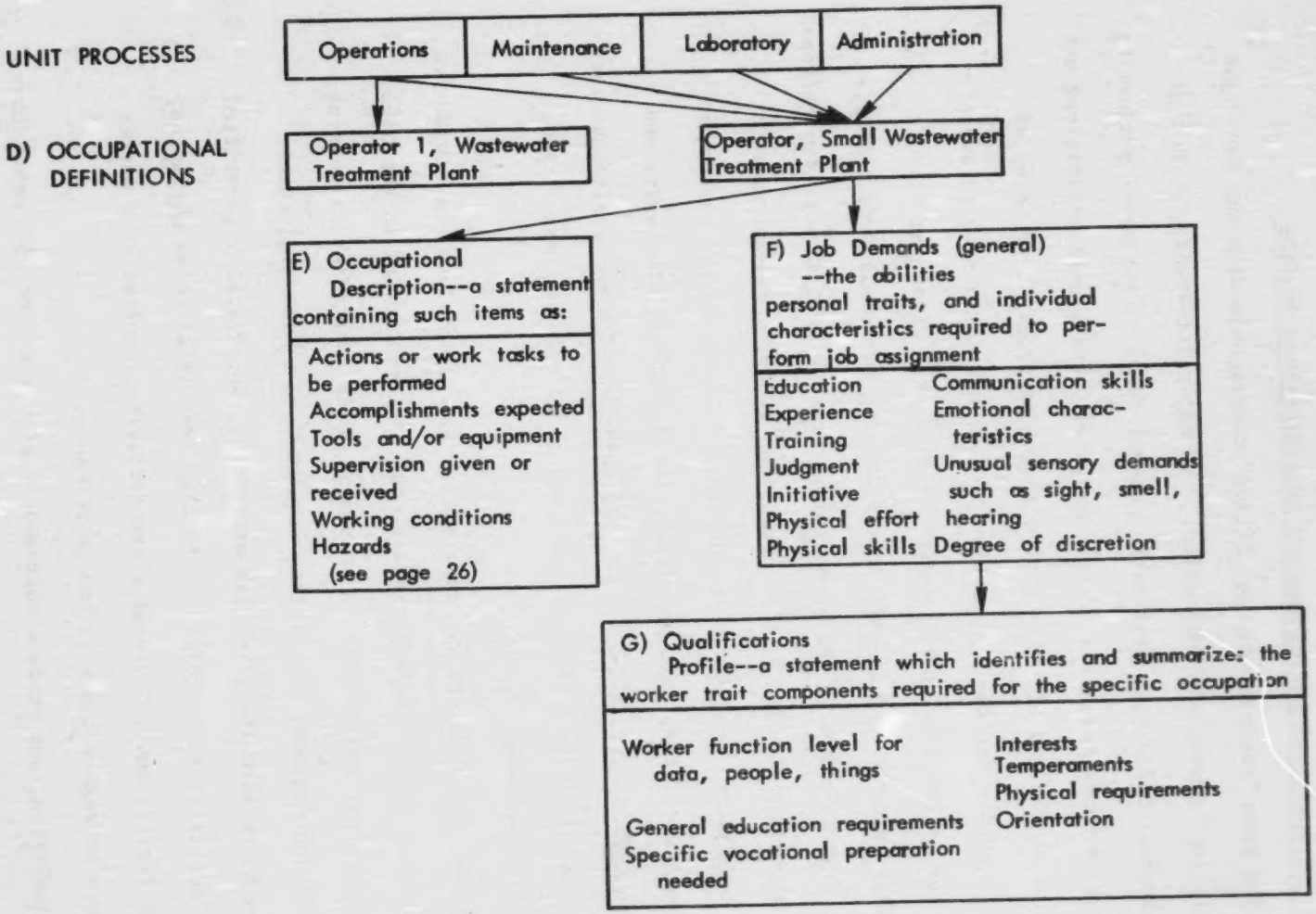

Fig. I-14. Additional steps required to perform a specific job.

1.6.9 Occupational Definition and Qualifications Profile

The term "occupational definition" corresponds with the term "job description" previously identified. The major difference is that an occupational definition applies in general terms to personnel performing a group of tasks (examples of two completed occupational definitions are provided at the end of this section of the manual). They serve as tools or guides for the preparation of job descriptions which are provided for as specific job or family of jobs at a given facility.

There are two significant inputs leading to occupational definitions. First, there is the quantitative process such as work simplification, methods engineering, time and motion study, and measurement. These methods are applied in the design and layout of the wastewater treatment facilities, unit processes, the design of work tasks, and the grouping of work tasks. They also coincide with the design and location of equipment to facilitate performance of required tasks often referred to as "human factors."

Second, the qualitative process (job study) involves the subjective determination of the characteristics that are required of an employee to perform a particular job. A statement which identifies in general terms the job demands, the minimum requirements of the individual selected to perform the given job assignment, is typically identified as the "qualifications profile." It also identifies those abilities, personal traits, and individual characteristics required of a worker to achieve average-successful job performance.

A qualifications profile corresponds with the term "job specifications." Again the major difference is the degree of generalization,

in that a job specification is prepared for a specific job at a given facility. The qualifications profile serves only as a model or planning tool. Often the term "occupational definition" used alone refers also to the qualifications profile.

It is recognized that work tasks may vary in complexity, from the simple to the highly complex, and thereby place differential demands upon the worker. The method used by the U.S. Employment Service for describing what workers do while performing a given work task recognizes that all work is related, in some manner, to data, people, or things.

> What workers do as they perform the tasks that make up their jobs, they do in relation to Data, People, and Things. All jobs involve the workers, to some extent, with information or ideas (data), with clients or co-workers (people), and with machines or equipment (things).

Each work task places unique demands upon the worker. If a task requires the worker to be involved with machines or equipment (things), the worker will use physical resources (strength, dexterity, motor coordination, etc.). Work tasks which require the worker to communicate and use information or ideas (data), will require the worker to use mental resources (knowledge, thought, decision making, insight, etc.). And finally, work which requires the worker to associate with customers, and co-workers (people), will require the worker to use interpersonal and social resources.

> The concrete and specific actions workers perform in relation to Data, People, and Things as they execute different tasks can probably be described in an infinite number of ways; that is, there are as many specific ways of expressing what workers do in relation to Data, People, and Things as there are specific tasks to be performed or unique content and conditions to which to relate. While there may be an infinite number of ways of describing tasks, there is only a handful of significant patterns of behavior (functions) which describe how workers use themselves in relation to Data, People, Things.

These patterns of behavior which have been articulated as describing generally the entire universe of work are defined in "worker function scales" (Fig. I-15).

> The functions in each of the three areas of Data, People, and Things can be defined by a Worker Function Scale, in which the performance requirements range from the simple to the complex in an ordinal scale. The scale is ordinal (that is, one in which any point on the scale includes lower levels and excludes the higher ones). For example, on scanning the Worker Function Scale for Data, when one selects the compiling function as the appropriate worker behavior to describe the way a worker must relate to information in a given task, he is deciding two things: (1) that the worker's performance is more complex than copying and less complex than analyzing; and (2) that the worker must be able to perform all or at least comprehend all the data functions below compiling, but does not have to be able to perform or comprehend higher functions such as analyzing or coordinating.

It is now possible to identify the "level" and "orientation" of a job which are measures of the job's requirements or demands on the individual (variable 8).

The level of a task indicates the relative complexity of a task. It is expressed by selecting the appropriate pattern of behavior on each of the worker function scales. The ordinal position of the function, on each scale, is the level measure. Thus, for the data function scale, tasks requiring computing and compiling are a higher level than those requiring only copying.

The orientation measure indicates the relative involvement of the worker with data, people, and things as he performs a given job assignment. For example, Table I-2 shows a job which requires 50% of the worker's time working with data at a copying level, 40% of the worker's time working with people in the exchange of information, and 10% of the worker's time relating to things at the handling level.

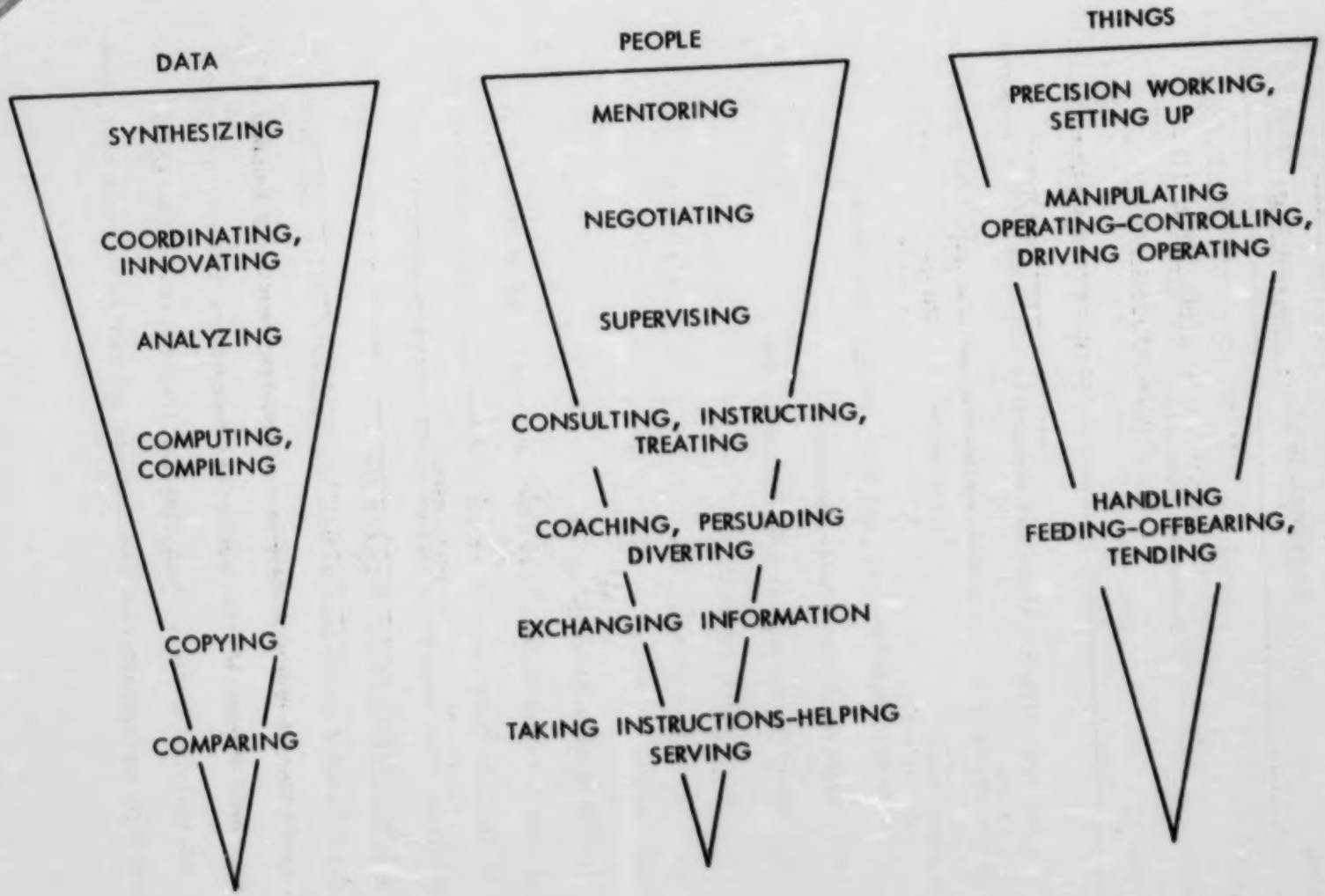

Fig. I-15. Summary chart of worker function scales.

Table I-2. Example job level and orientation profile.

Area	Functional level	Orientation
Data	Copying	50%
People	Exchange information	40%
Things	Handling	10%

A job specification therefore summarizes the worker trait components which are required of the worker assigned a specific job. The specification identifies:

1. Worker function level for data, people, and things
2. General education requirements
3. Specific vocational preparation needed
4. Approximate interest
5. Temperaments required
6. Physical demands of the job
7. Working conditions of the job.

A more detailed discussion of the "components and benchmarks" is used by the U.S. Department of Labor in describing worker characteristics and abilities that contribute to successful job performance.

1.6.9.1 Certification Requirements

Certification requirements which appropriately reflect job demands serve as a planning guide in determining training needs. The task list should be used extensively in developing statewide certification requirements and training courses. Each class or training period should be designed with appropriate task requirements and end performance objectives

defined. Completion of training phases should be followed by rigorous, yet realistic examinations. Proper training of plant personnel regarding how to perform operating and maintenance tasks, the impact of improper task performance, and the ability to "troubleshoot" problems as they occur and to take proper corrective action are of the utmost importance. For the small plant which is dependent upon a relatively small number of people, the training factor is crucial. As an aid to the small plant operation, it is important that:

1. Statewide certification standards be provided to assure that adequate capability and knowledge levels are maintained

2. Regional training courses in all phases of plant operation be continually made available

3. A competent professional staff be available through state agencies, private organizations, or other governmental units which can readily provide troubleshooting assistance, emergency relief, and perhaps aid as a "clearinghouse" in locating and placing qualified people in operating positions at small plants

4. Attention be given to wage scales and compensation plans to small plant personnel to encourage competent individuals to take the responsibility of plant operation.

Figure I-16 incorporates the planning tools, certification requirements (A), staffing guide (B), and occupation definitions (C) into the conceptual model.

1.6.10 Summary

The work performed by personnel associated with wastewater treatment plants is quite varied. It requires that each organization develop, for those positions within that organization, job descriptions relevant to specific job assignments. Only then can the appropriate job specifications be determined and written and proper selection, training and certification be performed.

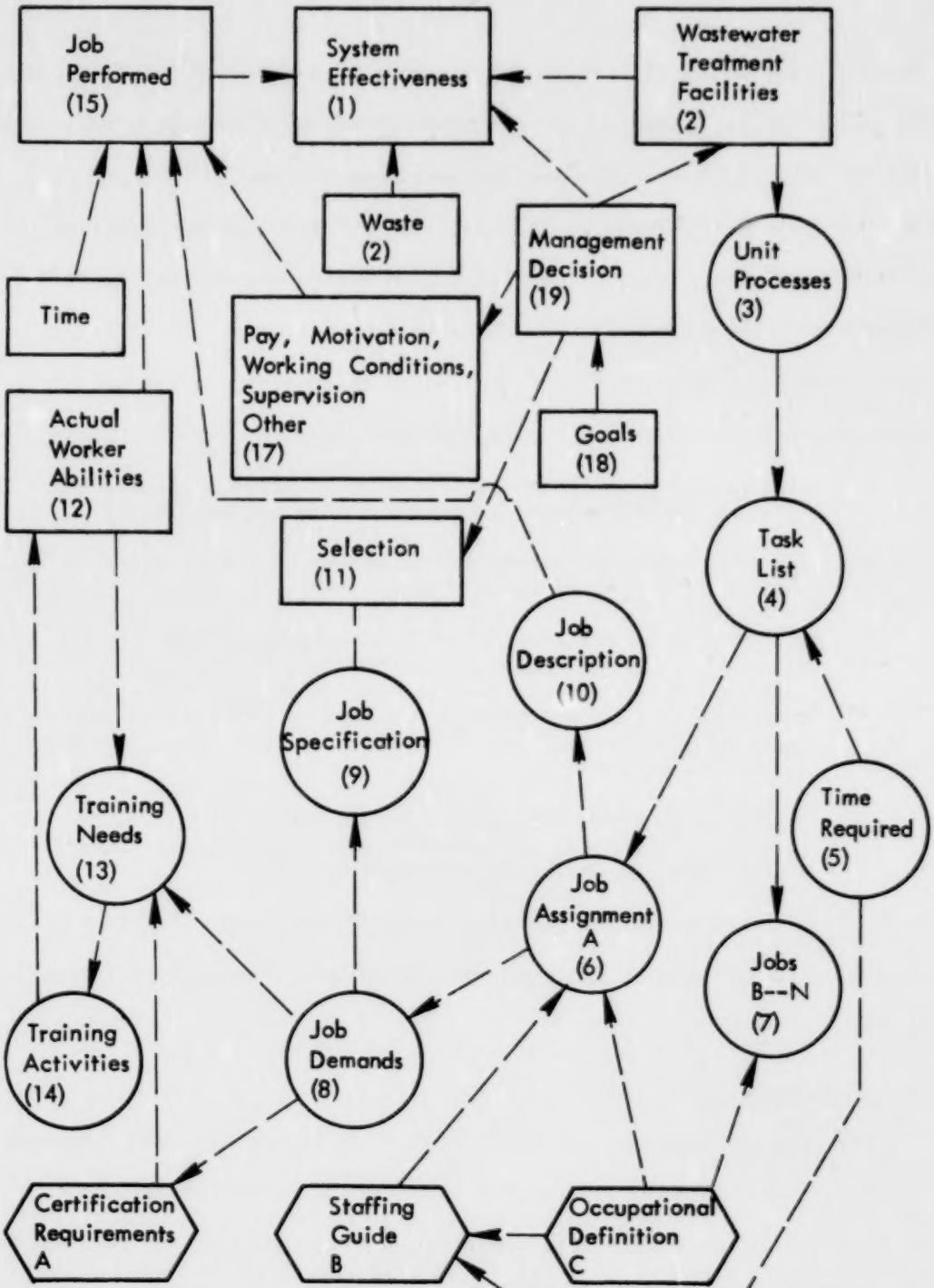

Fig. I-16. Incorporation of planning tools into the conceptual model.

The data supplied in this manual and the occupational descriptions and specifications can be used as guides to help develop job descriptions and specifications applicable to the specific positions within an organization. The analysis of the work being performed currently and consideration of future work requirements is a part of "system analysis" and the managers' responsibility.

1.7 Time Factor Measurement

Data obtained from wastewater treatment facilities visited by trained field engineers were stratified by process type and flow classification. This data provided information regarding the frequency and time necessary to accomplish each task. The time estimates from the field were stratified to take into account some of the variation that existed due to:

1. Nonstandardization of plant size and design
2. Nonstandardization of operator methodology
3. Nonstandardization of the measure of plant performance
4. Nonstandardization of operator training or experience
5. Nonstandardization of crew size, definition of duties, or job priorities
6. Low frequency of performance of many of the identifiable tasks.

A fundamental principle of work measurement is that the measurement be made on a well-defined job performed by a trained operator. The lack of existing standards of performance prevented this base. Where the work performed has a wide variation, the job is broken into elements for the purpose of reducing the variability in measurement. Each element

is then measured in such a manner as to obtain an estimate of the mean time and the dispersion of the time around the mean. In this instance, the variance reduction was accomplished by describing tasks within activities, plant size, and type. The structural hierarchy of this nesting of data is shown in Fig. I-17.

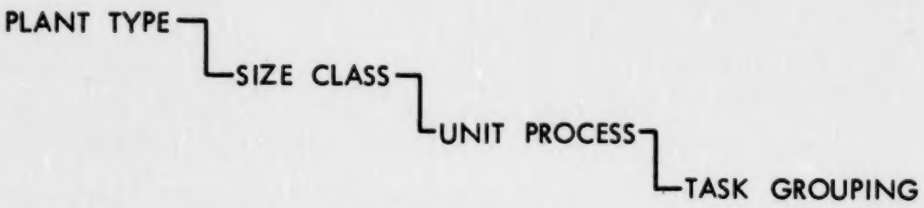

Fig. I-17. Time estimate stratification.

The data so collected provided a basis for a mean time against which a planner or supervisor may compare his projected or actual performance. Used in this way, the data provide a guideline to the planning factors necessary to adequate staffing of small wastewater treatment plants.

In obtaining the data, it was found that some of the tasks were performed daily, weekly, monthly, or annually. Further, some of the tasks were performed by more than one person. For example, sludge disposal or some of the maintenance functions may be done a few times a year by two men working together. Recognizing that these variations exist, the data were structured to permit a uniform and consistent means of estimating manpower needs. All data has been transformed to hours per week in the preparation of this planning guideline. Consequently, instructions for converting the data where the operation is to be used in frequencies other than weekly are provided where necessary.

1.8 Factors Affecting the Time Variability

A number of factors affect the operation of small facilities in a manner not unlike the phenomena experienced by larger plants. These factors have been discussed in previous studies reported to the Environmental Protection Agency. Principle among those which the small plant faces are:

1. Nondomestic waste. In the smaller communities the type of waste that enters the system may provide difficult control conditions. This is particularly true of a nonuniform influx that might result from creamery operations, packing plants, and other nondomestic processes which inject a heavy loading on the plant. A plant which has been properly designed and maintained will have fewer problems, but the operating tasks may well require higher-than-expected time duration.
2. Storm water. A shock load from ground water influx following a rain storm can be detrimental to the processes of wastewater treatment, particularly if the plant is operating at a marginal level of its design specifications. In any event, these surges create imbalances in the operation which again require higher-than-normal time requirements in the operating tasks.
3. Equipment condition. Plants operating with old equipment which has been properly maintained will require higher time factors in the maintenance-related tasks. This also is true of plants where the equipment has been improperly maintained, but this condition tends to create a requirement of higher-time factors for operational as well as maintenance-related

tasks. An attempt to reduce manpower requirements by cutting the tasks of housekeeping and other maintenance-related tasks will ultimately result in higher time requirements and other penalty costs.

4. Climate variations. Without question, certain factors are imposed by extreme temperature variations. However, the properly designed plant will minimize the impact of these factors. Extreme cold can create line-freeze problems which are costly to correct. Consequently, the frequency and duration of certain tasks may vary some with extreme conditions.

5. Operator training. Proper training of plant personnel regarding how to perform operating and maintenance tasks, the impact of improper task performance, and the ability to "troubleshoot" problems as they occur and to take proper corrective action is of the utmost importance. For the small plant which is dependent on a relatively small number of people, the training factor is crucial. As an aid to the small plant operation, it is important that:

   a) certification standards be provided to assure that adequate capability and knowledge levels are maintained

   b) regional training courses in all phases of plant operation be continually made available

   c) a competent professional staff be available through state agencies, private organizations, or other governmental units which can readily provide "troubleshooting" assistance, emergency relief, and perhaps aid as a "clearinghouse" in locating and placing qualified people in operating positions at small plants.

   d) that attention be given to wage scales and compensation plans to small plant personnel to encourage competent individuals to take the responsibility of plant operation.

1.9 Scope of the Manual

The previous discussion has presented the methodology of the study conducted to:

1. Adequately identify and describe the requirements of the job necessary to small plant operation
2. Specify the attributes necessary to meet the requirements of the job
3. Provide time factors to guide the planning for the number of people needed to staff the identified positions.

Since the detailed planning is a function of the tasks which must be performed, and the tasks are to a large degree specified by the plant design, the staffing requirement determination is a three-step process:

Step 1. Based on the specific plant design and process, the knowledge in each case of outside available maintenance assistance, and the particular emphasis that the responsible individual(s) for plant management may wish to take, the activities and tasks which are to be performed must be identified.

Step 2. For the selected tasks, the expected task time can be obtained from tables included in this manual.

Step 3. The task time must be allocated to the positions. If the resulting total time requirement is greater than a standard work week (herein assumed to be 40 hours), then multiple personnel are required within the same job description or assistance is needed in the form of one or more of the other described jobs. It may be desirable

to break the work time in order to spread it over the active treatment demand period. However specific shift breakdowns to cover periods in excess of a normal work day are not included herein.

Examples of the application of data presented appear in subsequent sections.

2. GENERAL APPLICATION

2.1 Typical Plant Profiles within the Scope of This Study

Three general types of facility for wastewater treatment in the size range 0-1 MGD were included within the scope of this study. These types were referenced in the preceding sections as types 1, 2, and 3 and are more fully described below. Plants included in this study were not required to chlorinate the discharge to streams. Package plants, lagoons, oxidation ditches, and processes other than described below are not included in this study.

Primary sedimentation: Primary sedimentation with separate sludge digestion followed by a trickling filter and final sedimentation tanks.

Treatment facilities of this type were found in all size ranges covered in this study. The unit processes found in this type plant included the following: a) usually a lift station at the plant; b) a screening device, sometimes bar screens and sometimes comminutors; c) grit chambers, both hand cleaned and mechanically cleaned; d) primary sedimentation tanks, usually with mechanical cleaning equipment although some hopper bottom tanks were provided; e) usually separate heated and/or unheated sludge digestion, although a few plants were filtering raw sludge for landfill disposal; f) primary sedimentation; g) followed by a trickling filter usually circular with a rotary distributor although some fixed nozzle filters were found; h) final sedimentation in either mechanically-cleaned sedimentation tanks or hopper-bottom sedimentation settling tanks. Sludge from the final sedimentation

tanks was returned by gravity to the wet wall of the lift station or pumped to the influent of the plant if a lift station is not provided; i) digested sludge is either dried on sand drying beds or wet hauled to agricultural land.

Imhoff tank: Imhoff tanks incorporating sedimentation and sludge digestion in a single unit followed by a trickling filter and final sedimentation tanks.

These facilities generally had a capacity of less than 0.3 MGD. The unit processes provided at these plants usually included: a) a lift station although in some instances gravity flow was possible; b) usually a screening device, commonly a hand-cleaned bar screen; c) sometimes a grit chamber generally hand cleaned; d) an Imhoff tank – either rectangular or circular; e) a trickling filter, almost always with a rotary distributor; f) a final sedimentation tank, oftentimes with a hopper bottom so that no mechanical cleaning equipment was needed. Sludge from the final sedimentation tank would flow by gravity back to the wet well of the pumping station and if no pumping station was provided, a lift pump was needed to pump the sludge back to the plant influent; g) sand drying beds were usually provided for drying of the digested sludge, which was disposed of on land or in a landfill.

Activated sludge: Completed mixed activated sludge system without primary sedimentation.

Activated sludge plants were found in all size ranges covered in this study. The unit processes found in this type of plant included the following: a) a lift station with the total raw waste flow going directly into b) aeration tanks;

c) sometimes through a bar screen or comminutor device (grit chambers were usually not provided). The activated sludge process used was either extended aeration or contact stabilization with most of the plants using diffused aeration with positive displacement blowers; d) final sedimentation tanks were equipped with scum baffles and if mechanical sludge removal was provided mechanical scum removal was also provided. Some of the final sedimentation tanks had hopper bottoms which required no mechanical equipment. Return sludge pumping to the aeration tanks was usually accomplished with air lift pumps; e) many plants were followed by small polishing lagoons; f) some plants were equipped with aerobic digestors for digesting waste activated sludge; and g) some were provided with sludge holding tanks while others had no provisions for sludge wasting.

2.2 Development and Organization of the Criteria

This study was designed to describe the variations in processes and tasks in the plant types described and also to account for time duration and frequency of task performance variations as the average flow increased through the range from 0 to 1 MGD. As a result the approach taken included separating the facility data and information by type and flow and to describe the tasks which generally must be performed for each of the ur processes.

The resulting 156 task items under 2-unit processes were identified as separate and distinct units. Basic data necessary as outlined in

Section 1.1 are the occupation descriptions which identify the scope of duties which a given occupation should be expected to perform and the background skill and knowledge levels which these occupations require. The time data for each of the tasks, and the identification of the minimum occupation level which should have the responsibility for proper performance of these tasks are also included.

It should be noted that the tasks for which times are included refer to normal preventive maintenance and simple repairs. In laboratory testing, many tests were not performed but the times reflect sample preparation for testing elsewhere.

2.3 Occupation Descriptions and Specifications Applicable to Small Plants

For the plant operation at the flow ranges in this study, five occupation levels have been identified. These are:

Operator II, small wastewater treatment plant

Operator I, small wastewater treatment plant

Shift Operator II, small wastewater treatment plant

Shift Operator I, small wastewater treatment plant

Helper, small wastewater treatment plant

A separate classification of superintendent reflecting the specialized type of supervision and a more expansive organization structure has not been included for facilities of this size. An operator carries the responsibilities of training and general supervision of the plant operation. His reporting level is most frequently to a member of the local governing authority and a more complex organization to include an intermediate supervision is not warranted.

Detailed description of these occupations are included on the following pages. It should be noted that the difference between Operator I and II exists in the vocational preparation. The Operator II level is distinguished by training beyond the 1-year level. The specific tasks which should be the responsibility of this level of training are identified in Section III.

2.3.1 Operator II (Small Wastewater Treatment Plant)*

2.3.1.1 Job Description

Operates wastewater treatment equipment to regulate flow and processing of wastewater and the waste solids produced. Monitors control panels and adjusts valves and gates manually or by remote control to regulate flow of wastewater and waste solids. Observes variations in operating conditions and interprets meter and gauge readings and test results to determine processing requirements. Starts and stops pumps, engines, and generators to control flows of chemicals, wastewater, and solids through the unit processes. May operate and maintain power generating equipment to provide heat and electricity for plant. May operate incinerator. Operates automotive equipment.

Analyzes and evaluates operation and maintenance functions for wastewater treatment plants processing an average daily flow of less than 1 million gallons; initiates or recommends new or improved practices. Controls expenditure of budgeted funds and requests approval for major expenditures, as required. Maintains effective communications and working relationships with other municipal employees, government officials, and general public. Composes routine correspondence and handles routine inquiries from the public. Maintains shift log and records meter and gauge readings.

Performs and/or supervises all preventive and corrective maintenance on plant and equipment except where he decides the work must be subcontracted out. Responsible for maintaining buildings, structures and grounds. Establishes preventive maintenance program and regularly inspects plant and mechanical equipment for malfunctions and needed repair. Keeps maintenance records. Performs craft-oriented duties (i.e., electrician, painter, plumber, etc.), along with general custodial tasks as required. Requisitions chemicals and supplies.

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*The detailed information which served as a base for the occupation description may be found in Handbook for Analyzing Jobs, U.S. Department of Labor, Manpower Administration, 1972 and Estimating Manpower Requirements and Selected Cost Factors for Small Wastewater Treatment Plants, Engineering Research Institute, Iowa State University, Ames, Iowa. 1973.

Collects samples of raw, partially treated and treated wastewater samples of waste solids (sludge) and other by-products. Assembles analytical instruments and prepares or arranges for purchase of test solutions routinely used in laboratory. Operates equipment and conducts tests to determine efficiency of plant operation to insure that plant effluent meets local, state, and federal requirements. Maintains test result records, data sheets and reports. Files reports as required with the proper enforcement authorities. Cleans, maintains and stores instruments and equipment. Maintains inventory and orders supplies. Performs custodial duties in laboratory.

2.3.1.2 Qualifications Profile

1. General educational development

   a. Reasoning

      1. Ability to apply knowledge of wastewater treatment principles to solve practical problems of plant operation

      2. Ability to interpret a variety of written, oral, or diagrammatic instructions

      3. Ability to apply principles of rational systems (bookkeeping, internal combustion engines, electric wiring systems) to solve practical problems of wastewater treatment.

   b. Mathematical

      1. Perform ordinary arithmetic and algebraic procedures in standard, practical applications

   c. Language

      1. Establish and maintain communications with superiors, co-workers and subcontractors

      2. Ability to comprehend oral and written instructions, record information and request supplies and work orally or in writing

      3. Ability to interpret technical manuals, blueprints and plant specifications

2. Specific vocational preparations

   a. Completion of operator training course or equivalent training and experience

   b. State operator certification, if applicable

c. Six to twelve months experience in wastewater treatment plant, depending upon formal training, prior experience and plant design

d. Training beyond the one-year level given in any of the following circumstances:

1. Vocational education (shop training, technical school)

2. In-plant training (training given by employer in form of organized classroom study)

3. On-the-job training (instruction given to trainee on the job by a qualified worker)

4. Essential experience in other jobs (experience received in less responsible jobs or other jobs which qualify for a higher grade job)

3. Aptitudes – relative to general working population*

a. Intelligence	Middle third
b. Verbal	
c. Numerical	
d. Spatial	
e. Form perception	
f. Clerical perception	
g. Motor coordination	
h. Finger dexterity	
i. Manual dexterity	
j. Eye-hand-foot coordination	
k. Color discrimination	

4. Interests*

a. Prefer activities of a routine, concrete, organized nature; dealing with things and objects as opposed to activities of an abstract or creative nature

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*See Appendix A for explanation of desired worker traits.

5. Temperaments*

   a. Situations involving a variety of tasks often characterized by frequent change as opposed to repetitive short cycle operations

   b. Situations involving the direction, planning and control of an entire activity or the activities of others

   c. Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others

6. Physical demands*

   a. Medium work; involving climbing, balancing, stooping, kneeling, crouching, reaching, handling and fingering

7. Working conditions*

   a. Both inside and outside; exposed to weather, fumes, odors, dust and toxic conditions; definite risk of bodily injury

ENTRY SOURCES: Operator I

PROGRESSION TO: Superintendent or Operator I of larger plant**

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*See Appendix A for explanation of desired worker traits.

**See Black and Veatch report[1].

JOB SPECIFICATION

1. Plant Location: _____

2. Job Title: Operator II - Small Wastewater Treatment Plant

3. Reports To: _____

4. Job Summary: Operates wastewater treatment, sludge processing, and disposal equipment to regulate flow and processing of wastewater, sludge, and effluent to insure that plant operation meets local, state, and/or federal requirements. See detailed job description.

5. Work Performed Ratings:

Worker Functions	Data	People	Things
	3	5	3

6. Worker Traits Ratings:

GED 1 2 (3) 4 5 6

SVP 1 2 3 4 (5) 6 7 8 9

Aptitudes G 3 V 3 N 3 S 3 P 3 Q 3 K 3 F 3 M 3 E 3 C 3

Temperaments (1) 2 3 (4) 5 (6) 7 8 9 0 X Y

Interests (1) 6 2 7 (3) 8 4 9 5 0

Phys. Demands S L (M) H A (2) (3) (4) 5 6

Environ. Cond. 1 0 (B) 2 3 (4) 5 (6) (7)

7 Other minimum requirements for job performance Additional training beyond the one-year level.

ENTRY SOURCES: Operator I

PROGRESSION TO: Superintendent or Operator I of larger plant

2.3.2 Operator I (Small Wastewater Treatment Plant)*

2.3.2.1 Job Description

Operates wastewater treatment equipment to regulate flow and processing of wastewater and the waste solids produced. Monitors control panels and adjusts valves and gates manually or by remote control to regulate flow of wastewater and waste solids. Observes variations in operating conditions and interprets meter and gauge readings and test results to determine processing requirements. Starts and stops pumps, engines, and generators to control flows of chemicals, wastewater, and solids through the unit processes. May operate and maintain power generating equipment to provide heat and electricity for plant. May operate incinerator. Operates automotive equipment.

Analyzes and evaluates operation and maintenance functions for wastewater treatment plants processing an average daily flow of less than 1 million gallons; initiates or recommends new or improved practices. Controls expenditure of budgeted funds and requests approval for major expenditures, as required. Maintains effective communications and working relationships with other municipal employees, government officials, and general public. Composes routine correspondence and handles routine inquiries from the public. Maintains shift log and records meter and gauge readings.

Performs and/or supervises all preventive and corrective maintenance on plant and equipment except where he decides the work must be subcontracted out. Responsible for maintaining buildings, structures, and grounds. Establishes preventive maintenance program and regularly inspects plant and mechanical equipment for malfunctions and needed repair. Keeps maintenance records. Performs craft-oriented duties (i.e., electrician, painter, plumber, etc.), along with general custodial tasks as required. Requisitions chemicals and supplies.

Collects samples of raw, partially treated and treated wastewater, samples of waste solids (sludge) and other by-products. Assembles analytical instruments and prepares or arranges for purchase of test solutions routinely used in laboratory. Operates equipment and conducts tests to determine efficiency of plant operation to insure that plant effluent meets local, state, and federal requirements. Maintains test result records, data sheets

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*The detailed information which served as a base for the occupation description may be found in Handbook for Analyzing Jobs, U.S. Department of Labor, Manpower Administration, 1972 and Estimating Manpower Requirements and Selected Cost Factors for Small Wastewater Treatment Plants, Engineering Research Institute, Iowa State University, Ames, Iowa. 1973.

and reports. Files reports as required with the proper enforcement authorities. Cleans, maintains, and stores instruments and equipment. Maintains inventory and orders supplies. Performs custodial duties in laboratory.

2.3.2.2 Qualifications Profile

1. General educational development

   a. Reasoning

      1. Ability to apply knowledge of wastewater treatment principles to solve practical problems of plant operation

      2. Ability to interpret a variety of written, oral, or diagrammatic instructions

   b. Mathematical

      1. Perform ordinary arithmetic and algebraic procedures in standard, practical applications

   c. Language

      1. Establish and maintain communications with superiors, co-workers and subcontractors

      2. Ability to comprehend oral and written instructions, record information and request supplies and work orally or in writing

      3. Ability to interpret technical manuals, blueprints and plant specifications

2. Specific vocational preparations

   a. Completion of operator training course or equivalent training and experience

   b. State operator certification, if applicable

   c. Six to twelve months experience in wastewater treatment plant, depending upon formal training, prior experience and plant design

3. Aptitudes – relative to general working population*

a. Intelligence	Middle third
b. Verbal	
c. Numerical	
d. Spatial	
e. Form perception	
f. Clerical perception	
g. Motor coordination	
h. Finger dexterity	
i. Manual dexterity	
j. Eye-hand-foot coordination	
k. Color discrimination	

4. Interests*

   a. Prefer activities of a routine, concrete, organized nature; dealing with things and objects as opposed to activities of an abstract or creative nature

5. Temperaments*

   a. Situations involving a variety of tasks often characterized by frequent change as opposed to repetitive short cycle operations

   b. Situations involving the direction, planning and control of an entire activity or the activities of others

   c. Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others

6. Physical demands*

   a. Medium work; involving climbing, balancing, stooping, kneeling, crouching, reaching, handling and fingering

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*See Appendix A for explanation of desired worker traits.

7. Working conditions*

   a. Both inside and outside; exposed to weather, fumes, odors, dust and toxic conditions; definite risk of bodily injury

ENTRY SOURCES: Shift Operator II

PROGRESSION TO: Operator II

*See Appendix A for explanation of desired worker traits.

JOB SPECIFICATION

1. Plant Location: _____

2. Job Title: Operator I - Small Wastewater Treatment Plant

3. Reports To: _____

4. Job Summary: Operates wastewater treatment, sludge processing, and disposal equipment to regulate flow and processing of wastewater, sludge, and effluent to insure that plant operation meets local, state, and/or federal requirements. See detailed job description.

5. Work Performed Ratings:

Worker Functions	Data	People	Things
	3	5	3

6. Worker Traits Ratings:

GED 1 2 (3) 4 5 6

SVP 1 2 3 4 (5) 6 7 8 9

Aptitudes G 3 V 3 N 3 S 3 P 3 Q 3 K 3 F 3 M 3 E 3 C 3

Temperaments (1) 2 3 (4) 5 (6) 7 8 9 0 X Y

Interests (1) 6 2 7 (3) 8 4 9 5 0

Phys. Demands S L (M) H A (2) (3) (4) 5 6

Environ. Cond. 1 0 (B) 2 3 (4) 5 (6) (7)

7. Other minimum requirements for job performance _____

_____

_____

ENTRY SOURCES: Shift Operator II

PROGRESSION TO: Operator II

2.3.3 Shift Operator II (Small Wastewater Treatment Plant)*

2.3.3.1 Job Description

Performs duties of the operator (small wastewater treatment plant) on shifts, but under supervision and direction. As is required on shifts, analyzes and evaluates operation and maintenance functions. Maintains effective communications and working relationships with other municipal employees. Composes routine correspondence, as required, and handles routine inquiries from operator. Maintains shift log and records meter and gauge readings.

Operates on shift the wastewater treatment equipment to regulate flow and processing of wastewater and sludge. Monitors control panels and adjusts valves and gates manually or by remote control to regulate flow of wastewater. Observes variations in operating conditions and interprets meter and gauge readings and test results to determine processing requirements. Starts and stops pumps, engines, and generators to control flow of raw sewage through the liquid stream treatment processes and waste solids produced through the sludge treatment processes. May operate and maintain power generating equipment to provide heat and electricity for plant. May operate incinerator. Operates automotive equipment.

Performs required preventive and corrective maintenance on plant and equipment as directed and under supervision. Maintains buildings, structures, and grounds. As directed, inspects plant and mechanical equipment for malfunctions and needed repair. Keeps maintenance records. Performs general custodial tasks.

Collects samples of raw, partially treated and treated wastewater, samples of waste solids (sludge) and other by-products as required. As directed, may operate equipment and conduct tests to determine efficiency of plant operation to insure that plant effluent meets local, state, and federal requirements. Maintains test result records, data sheets, and reports for the shift. Cleans, maintains and stores instruments and equipment. Performs custodial duties in laboratory as necessary.

2.3.3.2 Qualifications Profiles

1. General educational development

   a. Reasoning

      1. Ability to apply knowledge of wastewater treatment principles to solve practical problems of plant operation

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*The detailed information which served as a base for the occupation description may be found in Handbook for Analyzing Jobs, U.S. Department of Labor, Manpower Administration, 1972 and Estimating Manpower Requirements and Selected Cost Factors for Small Wastewater Treatment Plants, Engineering Research Institute, Iowa State University, Ames, Iowa. 1973.

2. Ability to interpret a variety of written, oral or diagrammatic instructions

b. Mathematical

1. Perform ordinary arithmetic and algebraic procedures in standard, practical applications

c. Language

1. Establish and maintain communications with superiors, coworkers

2. Ability to comprehend oral and written instructions, and record information

2. Specific vocational preparation

a. Completion of operator training course or equivalent training and experience

b. State operator certification, if applicable

c. Six to twelve months experience in wastewater treatment plant, depending upon formal training, prior experience and plant design

3. Aptitudes - relative to general working population*

a. Intelligence	Middle third
b. Verbal	
c. Numerical	
d. Spatial	
e. Form perception	
f. Clerical perception	
g. Motor coordination	
h. Finger dexterity	
i. Manual dexterity	
j. Eye-hand-foot coordination	
k. Color discrimination	

*See Appendix A for explanations of desired worker traits.

4. Interests*

   a. Prefer activities of a routine, concrete, organized nature; dealing with things and objects as opposed to activities of an abstract or creative nature

5. Temperaments*

   a. Situations involving a variety of tasks often characterized by frequent change as opposed to repetitive short cycle operations

   b. Situations involving the direction, planning and control of an entire activity or the activities of others

   c. Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others

6. Physical demands*

   a. Medium work; involving climbing, balancing, stooping, kneeling, crouching, reaching, handling and fingering

7. Working conditions*

   a. Both inside and outside; exposed to weather, fumes, odors, dust and toxic conditions; definite risk of bodily injury

ENTRY SOURCES: Shift Operator I

PROGRESSION TO: Operator I

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*See Appendix A for explanations of desired worker traits.

JOB SPECIFICATION

1. Plant Location: _____

2. Job Title: Shift Operator II - Small Wastewater Treatment Plant

3. Reports To: _____

4. Job Summary: Performs duties of operator - small plant - on shifts, but under supervision and/or direction of designated plant operator. See detailed job description.

5. Work Performed Ratings:

Worker Functions	Data	People	Things
	4	5	4

6. Worker Traits Ratings:

GED 1 2 (3) 4 5 6

SVP 1 2 3 4 (5) 6 7 8 9

Aptitudes G 3 V 3 N 3 S 3 P 3 Q 3 K 3 F 3 M 3 E 3 C 3

Temperaments (1) 2 3 (4) 5 (6) 7 8 9 0 X Y

Interests (1) 6 2 7 (3) 8 4 9 5 0

Phys. Demands S L (M) H V (2) (3) (4) 5 6

Environ. Cond. 1 0 (B) 2 3 (4) 5 (6) (7)

7. Other minimum requirements for job performance _____

ENTRY SOURCES: Shift Operator I

PROGRESSION TO: Operator I

2.3.4 Shift Operator I (Small Wastewater Treatment Plant)*

2.3.4.1 Job Description

Performs duties of the operator (small wastewater treatment plant) on shifts, but under supervision and direction. As is required on shifts, analyzes and evaluates operation and maintenance functions. Maintains effective communications and working relationships with other municipal employees. Composes routine correspondence, as required, and handles routine inquiries from operator. Maintains shift log and records meter and gauge readings.

Operates on shift the wastewater treatment equipment to regulate flow and processing of wastewater and sludge. Monitors control panels and adjusts valves and gates manually or by remote control to regulate flow of wastewater. Observes variations in operating conditions and interprets meter and gauge readings and test results to determine processing requirements. Starts and stops pumps, engines, and generators to control flow of raw sewage through the liquid stream treatment processes and waste solids produced through the sludge treatment processes. May operate and maintain power generating equipment to provide heat and electricity for plant. May operate incinerator. Operates automotive equipment.

Performs required preventive and corrective maintenance on plant and equipment as directed and under supervision. Maintains buildings, structures, and grounds. As directed, inspects plant and mechanical equipment for malfunctions and needed repair. Keeps maintenance records. Performs general custodial tasks.

Collects samples of raw, partially treated and treated wastewater, samples of waste solids (sludge) and other by-products as required. As directed, may operate equipment and conduct tests to determine efficiency of plant operation to insure that plant effluent meets local, state, and federal requirements. Maintains test result records, data sheets, and reports for the shift. Cleans, maintains and stores instruments and equipment. Performs custodial duties in laboratory as necessary.

2.3.4.2 Qualifications Profiles

1. General educational development

   a. Reasoning

      1. Ability to apply knowledge of wastewater treatment principles to solve practical problems of plant operation

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*The detailed information which served as a base for the occupation description may be found in Handbook for Analyzing Jobs, U.S. Department of Labor, Manpower Administration, 1972 and Estimating Manpower Requirements and Selected Cost Factors for Small Wastewater Treatment Plants, Engineering Research Institute, Iowa State University, Ames, Iowa. 1973.

2. Ability to interpret a variety of written, oral or diagrammatic instructions

b. Mathematical

1. Perform ordinary arithmetic and algebraic procedures in standard, practical applications

c. Language

1. Establish and maintain communications with superiors, co-workers

2. Ability to comprehend oral and written instructions, and record information

2. Specific vocational preparation

a. Completion of operator training course or equivalent training and experience

b. Three to six months experience in wastewater treatment plant, depending upon formal training, prior experience and plant design

3. Aptitudes - relative to general working population*

a. Intelligence	Middle third
b. Verbal	
c. Numerical	
d. Spatial	
e. Form perception	
f. Clerical perception	
g. Motor coordination	
h. Finger dexterity	
i. Manual dexterity	
j. Eye-hand-foot coordination	
k. Color discrimination	

*See Appendix A for explanations of desired worker traits.

4. Interests*

   a. Prefer activities of a routine, concrete, organized nature; dealing with things and objects as opposed to activities of an abstract or creative nature

5. Temperaments*

   a. Situations involving a variety of tasks often characterized by frequent change as opposed to repetitive short cycle operations

   b. Situations involving the direction, planning and control of an entire activity or the activities of others

   c. Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others

6. Physical demands*

   a. Medium work; involving climbing, balancing, stooping, kneeling, crouching, reaching, handling and fingering

7. Working conditions*

   a. Both inside and outside; exposed to weather, fumes, odors, dust and toxic conditions; definite risk of bodily injury

ENTRY SOURCES: Graduates of operator training courses, treatment plant helpers

PROGRESSION TO: Shift Operator II

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*See Appendix A for explanations of desired worker traits.

JOB SPECIFICATION

1. Plant Location: _____

2. Job Title: Shift Operator I - Small Wastewater Treatment Plant

3. Reports To: _____

4. Job Summary: Performs duties of operator - small plant - on shifts, but under supervision and/or direction of designated plant operator. See detailed job description.

5. Work Performed Ratings:

Worker Functions	Data	People	Things
	4	5	4

6. Worker Traits Ratings:

GED 1 2 (3) 4 5 6

SVP 1 2 3 4 (5) 6 7 8 9

Aptitudes G 3 V 3 N 3 S 3 P 3 Q 3 K 3 F 3 M 3 E 3 C 3

Temperaments (1) 2 3 (4) 5 (6) 7 8 9 0 X Y

Interests (1) 6 2 7 (3) 8 4 9 5 0

Phys. Demands S L (M) H V (2) (3) (4) 5 6

Environ. Cond. 1 0 (B) 2 3 (4) 5 (6) (7)

7. Other minimum requirements for job performance _____

ENTRY SOURCES: Graduates of operator training courses, treatment plant helpers

PROGRESSION TO: Shift Operator II

2.3.5 Helper (Small Wastewater Treatment Plant)*

2.3.5.1 Job Description

Assists operator I or II (small wastewater treatment plant) in the performance of any combination of tasks pertinent to controlling operation of plant or performs various tasks as directed. Under supervision of operator and as directed, operates wastewater treatment and sludge processing equipment to control flow and processing of wastewater, sludge and effluent. Cleans bar screens with rake and hose. Scrubs processing tanks, walkways, and other equipment with hose, brush, chemicals and detergents. Lubricates pumps, valves, and other equipment using grease gun. Opens and closes manually or remotely operated gates and valves according to gauge readings or warning lights. Collects samples of raw, partially treated and treated wastewater and by-products for tests. Loads materials into containers, using shovels, forks, and special purchase tools. Loads and unloads trucks; spreads sand, gravel, or dirt. Cleans drains, ditches, and culverts. Cuts grass, leaves, and brush; rakes grass, leaves, and trash; seeds and cares for grass. Removes snow and ice from walkways, driveways, and equipment. Collects and disposes of trash, garbage and sludge.

Under close supervision, extracts samples and performs routine laboratory tests and analyses. Performs routine maintenance functions and custodial duties. Operates and performs maintenance on vehicles.

2.3.5.2 Qualifications Profiles

1. General educational department

   a. Reasoning

      1. Apply common sense understanding to carry out simple instructions

   b. Mathematical

      1. Perform arithmetic calculations for purposes of counting and recording

   c. Language

      1. Ability to learn job duties from oral instructions or demonstrations and request supplies and materials orally

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*The detailed information which served as a base for the occupation description may be found in Handbook for Analyzing Jobs, U.S. Department of Labor, Manpower Administration, 1972 and Estimating Manpower Requirements and Selected Cost Factors for Small Wastewater Treatment Plants, Engineering Research Institute, Iowa State University, Ames, Iowa. 1973.

2. Specific vocational preparation

   a. On-the-job training or previous experience as a laborer

3. Aptitudes – relative to general working population*

a. Intelligence	Lowest third, excluding bottom 10%
b. Verbal	
c. Numerical	
d. Spatial	
e. Form perception	
f. Clerical perception	
g. Motor coordination	Middle third
h. Finger dexterity	
i. Manual dexterity	
j. Eye-hand-foot coordination	
k. Color discrimination	

4. Interests*

   a. Preference for activities dealing with things and objects

   b. Situations involving a preference for activities of a routine, concrete, organized nature as opposed to activities of an abstract or creative nature

5. Temperaments*

   a. Situations involving doing things only under specific instruction, allowing little room for independent action or judgment in working out job problems

   b. Situations involving working alone and apart in physical isolation from others

   c. Situations involving a variety of duties characterized by frequent change as opposed to repetitive short cycle operations

---

*See Appendix A for explanations of desired worker traits.

6. Physical demands*

   a. Heavy work involving lifting objects, climbing, balancing, stooping, kneeling, crouching, crawling, reaching and handling

7. Working conditions*

   a. Primarily outside with no protection from weather; exposed to fumes, odors and toxic conditions; definite risk of bodily injury

ENTRY SOURCES: Unskilled labor market

PROGRESSION TO: Shift Operator I

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*See Appendix A for explanations of desired worker traits.

JOB SPECIFICATION

1. Plant Location: _____

2. Job Title: Helper - Small Wastewater Treatment Plant

3. Reports To: _____

4. Job Summary: Assists in shift operation – small plant – in the performance of any combination of tasks pertinent to controlling operation of plant or performs various tasks as directed or under operator's supervision. See detailed job description.

5. Work Performed Ratings:

Worker Functions	Data	People	Things
	5	6	5

6. Worker Traits Ratings:

GED 1 (2) 3 4 5 6

SVP 1 (2) 3 4 5 6 7 8 9

Aptitudes G 4 V 4 N 4 S 4 P 4 Q 4 K 3 F 3 M 3 E 3 C 3

Temperaments (1) 2 (3) 4 5 (6) 7 8 9 0 X Y

Interests (1) 6 2 7 (3) 8 4 9 5 0

Phys. Demands S L M (H) V (2) (3) (4) 5 6

Environ. Cond. 1 (0) B 2 3 (4) 5 (6) (7)

7. Other minimum requirements for job performance _____

_____

_____

ENTRY SOURCES: Unskilled labor market

PROGRESSION TO: Shift Operator I

2.4 Unit Processes and Tasks on Which Guidelines Are Based

The following table indicates the major processes and the tasks identified within process which were used as the basis for developing staffing guidelines. Some of the tasks represent small adjustments and minor repair as in the case of time spent on raw wastewater pumps and sludge pumps. In other cases they represent routine checking and adjustment through valves such as flow rate adjustment. Other processes are highly variable in content based on the extent to which the job is required, e.g., preparation of samples for testing elsewhere versus completing the testing on site or chlorination within the process for odor control, etc. In this latter case, the plants studied were not required to chlorinate the effluent.

Table I-3. Tasks which are identified with each unit process.

Process 1: Sewer and lift station maintenance

Task (a) Inspection of sewers and lift stations
(b) Maintenance of sewer lines
(c) Maintenance of lift pumps
(d) Other maintenance
(e) Other operation

Process 2: Screening or comminuting tasks

Task (a) Hand cleaning of screens
(b) Removal of debris (screenings)
(c) Disposal of debris (screenings)
(d) Comminutor cleaning
(e) Maintenance of mechanical screens
(f) Maintenance of comminutor
(g) Housekeeping
(h) Sampling for lab tests
(i) Other maintenance
(j) Other operation

Process 3: Grit removal

Task (a) Hand cleaning grit chambers
(b) Mechanical grit removal
(c) Maintenance of equipment
(d) Analysis of grit
(e) Housekeeping
(f) Other maintenance
(g) Other operation

Process 4: Primary settling tanks

Task (a) Inspection of mechanical equipment
(b) Maintenance of mechanical equipment
(c) Other general maintenance
(d) Inspection of process-adjust flow
(e) Scum removal
(f) Cleaning scum removal equipment
(g) Cleaning baffles-weirs
(h) Sludge collection
(i) Raw sludge pumping
(j) Housekeeping
(k) Sampling for lab tests
(l) Other maintenance
(m) Other operation

Process 5: Imhoff tanks

Task (a) Inspection and flow rate adjustment
(b) Maintenance of equipment
(c) Squeegeeing the walls
(d) Scum removal
(e) Cleaning the slot
(f) Sludge removal
(g) Record
(h) Measuring sludge depth
(i) Samples for lab tests
(j) Other maintenance
(k) Other operation

Table I-3. Continued.

Process 6: Sludge digestion

Task (a) Temperature control and boiler operation
(b) Boiler maintenance
(c) Check sludge, water, gas lines
(d) Maintenance of sludge, water, gas lines
(e) Maintenance of sludge mixing equipment
(f) Maintenance of pumps
(g) Electrical maintenance
(h) Other mechanical maintenance
(i) Sludge pumping (other than raw sludge)
(j) Scum control
(k) Sludge conditioning
(l) Gas collection and control (include drip trap emptying)
(m) Withdrawal of supernatant
(n) Withdrawal of digested sludge
(o) Record keeping
(p) Sampling for lab tests
(q) Housekeeping
(r) Other maintenance
(s) Other operation

Process 7: Digested sludge dewatering and disposal

Task (a) Drying bed preparation
(b) Wet hauling sludge
(c) Lagooning
(d) Burial
(e) Landfill
(f) Other maintenance
(g) Other operation

Process 8: Activated sludge tasks

Task (a) Inspection of equipment
(b) Return pump maintenance
(c) Aerator or blower maintenance
(d) Cleaning air diffusers
(e) Other electrical maintenance
(f) Other mechanical maintenance
(g) Return sludge-rate adjustment
(h) Aeration rate adjustment
(i) Sludge thickening
(j) Sludge removal
(k) Disposal of sludge
(l) Record keeping – reports
(m) Sampling of sludge for lab tests
(n) Housekeeping
(o) Polishing, lagooning, maintenance
(p) Other maintenance
(q) Other operation

Process 9: Trickling filter tasks

Task (a) Pump maintenance
(b) Maintenance of filter bed
(c) Electrical maintenance
(d) Other mechanical maintenance
(e) Cleaning arms
(f) Cleaning under drains
(g) Cleaning filter bed
(h) Inspection – flow adjustment (recirculation)
(i) Record keeping – reports
(j) Filter fly control
(k) Ice control
(l) Other maintenance
(m) Other operation

Table I-3. Continued.

Process 10: Final settling tank(s) (clarifiers)

Task (a) Inspection of mechanical equipment
(b) Maintenance of mechanical equipment
(c) Other general maintenance
(d) Inspection of process-adjust flow
(e) Scum removal
(f) Cleaning scum removal equipment
(g) Cleaning baffles-weirs
(h) Sludge collection
(i) Raw sludge pumping
(j) Housekeeping
(k) Sampling for lab tests
(l) Other maintenance
(m) Other operation

Process 11: Laboratory control

Wastewater solids determination

Task (a) Total
(b) Suspended
(c) Settleable
(d) Volatile solids
(e) Sludge solids
(f) BOD
(g) pH
(h) Grease
(i) Dissolved oxygen
(j) Residual chlorine
(k) Coliform organisms
(l) COD
(m) Relative stability
(n) Weather
(o) Volatile acids
(p) Sludge volume or sludge density index
(q) Dishwashing
(r) Record keeping
(s) Lab maintenance
(t) Housekeeping
(u) Other maintenance
(v) Other operation

Process 12: Miscellaneous tasks

Task (a) Maintenance of control system
(b) Maintenance checks
(c) Electrical checks
(d) Electrical repair
(e) Pump lubrication
(f) Pump packing
(g) Planning
(h) Supervision
(i) Training
(j) Housekeeping
(k) Grounds keeping
(l) Safety equipment maintenance
(m) Ventilation equipment maintenance
(n) Chlorination
(o) Sampling of flow
(p) Record keeping (not recorded earlier)
(q) Other maintenance
(r) Other operation

3. GUIDELINES RELATING OCCUPATION DESCRIPTIONS, TASKS, AND TIME ESTIMATES

On the following tables, the data are presented relating the identified processes and tasks to average time requirements and minimum occupation levels. The time requirements are stated in hours per week. All time estimates have been normalized to this base regardless of daily, weekly, monthly or other frequencies of performance. To convert the time requirements to any other base, the following adjustments should be made.

Desired frequency	Task time in man-hours
Daily	[Time from Table] ÷ 7
Weekly	Time from Table
Monthly	[Time from Table] x 4
Annually	[Time from Table] x 52

Table I-4. Average hours per week on tasks associated with treatment type 1.

Primary sedimentation system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	Minimum required occupational level
Unit process: sewer and lift station maintenance						
Task a – Inspection of sewers and lift stations	1.38	2.33	3.00	3.40	5.00	Shift Operator II
b – Maintenance of sewer lines	2.20	2.50	2.90	3.20	3.40	Helper
c – Maintenance of lift pumps	0.30	0.70	1.20	1.70	2.00	Shift Operator II
d – Other maintenance	0.07	0.13	2.20	2.30	2.70	Helper
e – Other operation	0.26	0.35	0.43	0.46	0.51	Helper
Unit process: screening or comminuting						
a – Hand cleaning of screens	1.00	1.67	2.00	2.30	2.60	Helper
b – Removal of debris (screenings)	0.31	0.43	0.49	0.51	0.53	Helper
c – Disposal of debris (screenings)	0.52	0.92	1.16	1.35	1.50	Helper
d – Comminutor cleaning	1.30	1.20	1.15	1.10	1.04	Shift Operator I
e – Maintenance of screens	0.48	0.28	0.23	0.20	0.17	Shift Operator I
f – Maintenance of comminutor	0.23	0.22	0.20	0.19	0.18	Shift Operator I
g – Housekeeping	0.30	0.46	0.56	0.64	0.68	Helper
h – Sampling for lab tests	1.00	1.00	1.00	1.00	1.00	Shift Operator I
i – Other maintenance	0.23	0.14	0.12	0.10	0.09	Helper
j – Other operation	1.20	1.20	1.20	1.20	1.20	Helper
Unit process: grit removal						
a – Hand cleaning grit chambers	0.78	1.17	1.42	1.55	1.69	Helper
b – Mechanical grit removal	0.58	1.34	1.74	2.33	3.00	Shift Operator I
c – Maintenance of equipment	0.38	0.54	0.65	0.72	0.78	Shift Operator II
d – Housekeeping	0.65	0.74	0.83	0.85	0.93	Helper
e – Other maintenance	0.08	0.17	0.24	0.30	0.37	Helper
f – Other operation	1.02	1.18	1.27	1.33	1.38	Helper

Table I-4. Continued.

Primary sedimentation system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	Minimum required occupational level
Unit process: primary settling tank						
a – Inspection of mechanical equipment	0.43	0.63	0.74	0.84	0.94	Shift Operator II
b – Maintenance of mechanical equipment	0.29	0.34	0.40	0.43	0.44	Shift Operator II
c – Other general maintenance	0.13	0.23	0.28	0.30	0.38	Helper
d – Inspection of process-adjust flow	0.03	0.23	0.58	1.08	1.67	Operator I
e – Scum removal	3.50	2.60	2.30	2.00	2.00	Helper
f – Cleaning scum removal equipment	1.06	1.19	1.34	1.40	1.46	Helper
g – Cleaning baffles-weirs	0.20	0.24	0.30	0.33	0.38	Helper
h – Sludge collection	0.43	0.46	0.47	0.47	0.47	Shift Operator I
i – Raw sludge pumping	0.43	0.60	0.67	0.75	0.81	Shift Operator I
j – Housekeeping	0.14	0.50	0.90	1.25	1.67	Helper
k – Sampling for lab tests	0.50	0.38	0.33	0.30	0.29	Shift Operator I
l – Other maintenance	0.23	0.25	0.27	0.28	0.30	Helper
m – Other operation	1.67	0.70	0.47	0.34	0.28	Helper
Unit process: sludge digestion						
a – Temperature control and boiler operation	0.53	0.93	1.23	1.45	1.67	Operator I
b – Boiler maintenance	0.30	0.28	0.27	0.26	0.25	Operator II
c – Check sludge, water, gas lines	0.13	0.30	0.43	0.53	0.65	Operator I
d – Maintenance of sludge, water, gas lines	0.04	0.10	0.14	0.19	0.23	Operator I
e – Maintenance of sludge mixing equipment	0.09	0.16	0.20	0.25	0.27	Operator I
f – Maintenance of pumps	0.14	0.25	0.32	0.38	0.43	Operator I
g – Other mechanical maintenance	0.03	0.07	0.10	0.13	0.17	Shift Operator II
h – Sludge pumping	0.83	2.08	3.17	4.17	5.33	Shift Operator II
i – Scum control	–	0.21	0.78	1.83	3.50	Shift Operator II
j – Sludge conditioning	0.13	0.11	0.10	0.09	0.09	Operator II
k – Gas collection and control (inc. drip trap empty)	0.21	0.38	0.50	0.60	0.68	Shift Operator II

Table I-4. Continued.

Primary sedimentation system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	Minimum required occupational level
l – Withdrawal of supernatant	0.57	0.90	1.12	1.28	1.42	Shift Operator II
m – Withdrawal of digested sludge	0.65	1.00	1.25	1.42	1.57	Shift Operator II
n – Sampling for lab tests	2.60	1.52	1.13	0.93	0.83	Shift Operator II
o – Housekeeping	0.15	0.25	0.32	0.37	0.42	Helper
p – Other maintenance	0.09	0.22	0.32	0.42	0.50	Helper
q – Other operation	0.03	0.09	0.14	0.19	0.25	Helper
Unit process: digested sludge dewatering and disposal						
a – Drying bed preparation	1.50	1.90	1.95	2.20	2.75	Helper
b – Wet hauling sludge	1.83	2.42	2.80	3.00	3.25	Helper
c – Lagooning	3.00	3.43	3.67	3.83	4.00	Shift Operator I
d – Landfill	1.87	2.13	2.28	2.37	2.45	Shift Operator I
e – Other maintenance	0.58	0.51	0.48	0.47	0.45	Helper
Unit process: trickling filter tasks						
a – Pump maintenance	0.11	0.37	0.65	0.93	1.25	Operator I
b – Maintenance of tanks	0.45	0.60	0.68	0.73	0.80	Shift Operator II
c – Other electrical maintenance	0.05	0.05	0.05	0.05	0.05	Operator I
d – Other mechanical maintenance	0.14	0.23	0.29	0.33	0.38	Shift Operator II
e – Cleaning arms	1.60	1.53	1.50	1.48	1.47	Helper
f – Cleaning under drains	0.83	0.98	1.07	1.10	1.15	Helper
g – Cleaning tanks	0.93	0.53	0.40	0.34	0.30	Helper
h – Inspection – flow adjustment	0.47	0.43	0.42	0.42	0.41	Operator I
i – Filter fly control	0.24	0.21	0.19	0.18	0.18	Operator I
j – Ice control	1.00	2.28	3.33	4.17	5.00	Shift Operator II
k – Other maintenance	0.19	0.22	0.23	0.23	0.24	Helper
l – Other operation	0.29	0.20	0.17	0.16	0.14	Helper

Table I-4. Continued.

Primary sedimentation system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	Minimum required occupational level
Unit process: final settling tank						
a – Inspection of mechanical equipment	0.38	0.60	0.73	0.83	0.93	Shift Operator II
b – Maintenance of mechanical equipment	0.06	0.14	0.22	0.30	0.35	Shift Operator II
c – Other general maintenance	0.13	0.23	0.30	0.37	0.42	Shift Operator I
d – Inspection of process-adjust flow	0.12	0.22	0.29	0.35	0.40	Operator I
e – Scum removal	0.31	0.45	0.53	0.60	0.64	Helper
f – Cleaning scum removal equipment	0.23	0.28	0.31	0.33	0.34	Helper
g – Cleaning baffles-weirs	1.70	1.93	2.03	2.10	2.17	Helper
h – Sludge collection	2.92	4.50	5.50	6.33	7.00	Shift Operator I
i – Raw sludge pumping	0.73	1.83	2.72	3.50	4.33	Shift Operator II
j – Housekeeping	0.25	0.31	0.35	0.37	0.38	Helper
k – Sampling for lab tests	0.35	0.25	0.22	0.20	0.18	Shift Operator II
l – Other maintenance	0.09	0.16	0.21	0.25	0.29	Helper
m – Other operation	0.50	0.42	0.27	0.20	0.16	Helper
Unit process: laboratory control*						
a – Total	0.52	0.52	0.52	0.52	0.52	Operator I
b – Suspended	3.00	1.40	0.95	0.77	0.65	Operator I
c – Settleable	1.75	1.52	1.42	1.37	1.33	Shift Operator II
d – Volatile solids	0.35	0.57	0.70	0.80	0.88	Operator I
e – Sludge solids	0.18	0.28	0.34	0.39	0.43	Operator I
f – BOD	0.02	0.20	0.60	1.07	2.17	Operator II
g – pH	0.73	0.95	1.07	1.15	1.20	Operator I
h – Dissolved oxygen	0.50	0.64	0.72	0.77	0.83	Operator I
i – Relative stability	0.59	0.90	1.10	1.27	1.40	Shift Operator II
j – Weather	1.75	1.42	1.25	1.17	1.12	Shift Operator II
k – Volatile acids	0.75	1.00	1.12	1.25	1.50	Operator II
l – Sludge volume of sludge density index	0.10	0.22	0.35	0.48	0.60	Operator II

*Variation due to frequency and sampling only rather than completing full test.

Table I-4. Continued.

Primary sedimentation system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	Minimum required occupational level
m – Dishwashing	1.12	1.50	1.97	2.20	2.42	Helper
n – Record keeping	1.25	2.62	3.58	4.58	5.33	Operator I
o – Lab maintenance	0.97	1.12	1.22	1.28	1.33	Helper
p – Housekeeping	0.63	1.25	1.67	2.10	2.47	Helper
q – Other maintenance	0.40	0.33	0.30	0.28	0.27	Helper
r – Other operation	0.57	1.20	1.70	2.17	2.58	Helper
Unit process: miscellaneous tasks						
a – Maintenance of control system	–	0.05	0.09	0.12	0.15	Operator II
b – Maintenance checks	0.14	0.20	0.23	0.24	0.26	Operator I
c – Pump lubrication	0.02	0.03	0.03	0.03	0.04	Shift Operator II
d – Pump packing	0.05	0.06	0.06	0.06	0.07	Shift Operator II
e – Planning	1.43	1.58	1.67	1.73	1.82	Operator I
f – Supervision	4.50	4.50	4.50	4.50	4.50	Operator I
g – Training	–	0.33	1.83	5.67	12.50	Operator I
h – Housekeeping	1.83	2.37	2.70	3.00	3.17	Helper
i – Grounds keeping	6.85	7.50	7.67	7.83	8.00	Helper
j – Safety equipment maintenance	–	0.01	0.04	0.09	0.17	Operator I
k – Ventilation equipment maintenance	0.19	0.25	0.28	0.30	0.32	Operator I
l – Chlorination	1.50	1.50	1.50	1.50	1.50	Operator I
m – Sampling of flow	1.25	0.83	0.71	0.63	0.58	Shift Operator II
n – Other maintenance	0.80	0.38	0.27	0.22	0.18	Helper
o – Other operation	0.36	0.30	0.27	0.25	0.23	Helper

Table I-5. Average hours per week on tasks associated with treatment type 2.

Imhoff tank system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	Minimum required occupational level
Unit process: sewer and lift stations maintenance				
a – Inspection of sewers and lift stations	4.00	4.67	5.00	Shift Operator II
b – Maintenance of sewer lines	1.45	1.30	1.23	Helper
c – Maintenance of lift pumps	0.68	1.00	1.18	Shift Operator II
Unit process: screening or comminuting tasks				
a – Hand cleaning of screens	1.92	0.78	0.53	Helper
b – Removal of debris (screenings)	1.22	0.38	0.22	Helper
c – Disposal of debris (screenings)	0.55	0.58	0.60	Helper
d – Housekeeping	0.67	0.58	0.54	Helper
e – Sampling for lab tests	1.23	0.83	0.68	Shift Operator II
f – Other maintenance	0.07	0.25	0.45	Helper
Unit process: Imhoff tanks				
a – Inspection and flow adjustment	0.90	1.33	1.60	Operator I
b – Maintenance of equipment	0.28	0.32	0.33	Operator I
c – Squeegeeing the walls	0.93	3.33	5.67	Helper
d – Scum removal	1.83	1.07	0.82	Helper
e – Cleaning the slot	0.83	0.63	0.55	Helper
f – Sludge removal	0.34	0.25	0.21	Shift Operator I
g – Measuring sludge depth	0.16	0.04	0.02	Shift Operator II
h – Other maintenance	0.44	0.02	0.00	Helper
i – Other operation	1.23	5.50	11.00	Helper

Table I-5. Continued.

Imhoff tank system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	Minimum required occupational level
Unit process: digested sludge dewatering and disposal				
a – Wet hauling sludge	1.58	0.85	0.63	Helper
b – Landfill	0.93	0.58	0.48	Shift Operator I
Unit process: trickling filter tasks				
a – Pump maintenance	0.70	0.22	0.12	Operator I
b – Maintenance of tanks	0.98	0.27	0.14	Shift Operator II
c – Cleaning arms	1.67	0.53	0.32	Helper
d – Cleaning under drains	0.70	0.82	0.88	Helper
e – Cleaning tanks	0.93	0.63	0.43	Helper
f – Filter fly control	0.28	0.82	1.33	Operator I
g – Ice control	2.50	1.03	0.70	Shift Operator II
h – Other maintenance	1.97	4.20	9.33	Helper
i – Other operation	0.18	0.19	0.20	Helper
Unit process: final settling tanks				
a – Inspection of mechanical equipment	0.92	0.63	0.58	Shift Operator II
b – Maintenance of mechanical equipment	0.14	0.08	0.06	Shift Operator II
c – Scum removal	0.08	0.25	0.42	Helper
d – Cleaning baffles-weirs	1.30	1.47	1.55	Helper
e – Sludge collection	0.04	1.00	4.50	Shift Operator I
f – Raw sludge pumping	1.02	0.58	0.43	Shift Operator II
g – Housekeeping	0.54	1.07	1.43	Helper
h – Sampling for lab tests	0.16	0.23	0.37	Shift Operator II

Table I-5. Continued.

Imhoff tank system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	Minimum required occupational level
Unit process: laboratory control*				
a – Settleable	1.45	1.83	2.05	Shift Operator II
b – BOD	0.01	0.15	0.67	Operator II
c – pH	1.10	0.83	0.73	Operator I
d – Dissolved oxygen	0.68	2.50	4.58	Operator I
e – Relative stability	1.07	0.83	0.73	Shift Operator II
f – Weather	0.83	0.97	1.05	Shift Operator II
g – Dishwashing	1.17	1.67	1.95	Helper
h – Record keeping	1.33	0.73	0.57	Operator I
i – Lab maintenance	0.33	3.50	10.30	Helper
j – Housekeeping	0.95	0.38	0.25	Helper
k – Other operation	0.22	0.38	0.48	Helper
Unit process: Miscellaneous tasks				
a – Planning	1.92	2.50	2.83	Operator I
b – Supervision	3.75	5.00	5.67	Operator I
c – Housekeeping	0.83	0.95	1.00	Helper
d – Grounds keeping	2.73	1.53	1.17	Helper
e – Other maintenance	0.40	0.77	1.07	Helper

Note: For tasks not included, use time estimate from primary sedimentation systems as an approximation.

*Variations due to frequency and sampling only rather than completing full test.

Table I-6. Average hours per week on tasks associated with treatment type 3.

Activated sludge system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	Minimum required occupational level
Unit process: sewer and lift station maintenance						
a – Inspection of sewers and lift stations	0.60	0.67	0.70	0.72	0.73	Shift Operator II
b – Maintenance of lift pumps	0.47	0.18	0.12	0.09	0.07	Shift Operator II
c – Other maintenance	0.28	0.19	0.15	0.14	0.13	Helper
Unit process: screening or comminuting tasks						
a – Hand cleaning of screens	0.48	0.73	0.90	1.00	1.10	Helper
b – Removal of debris (screenings)	0.18	0.28	0.33	0.37	0.41	Helper
c – Disposal of debris (screenings)	0.28	0.49	0.63	0.77	0.88	Helper
d – Comminutor cleaning	0.52	0.77	0.93	1.05	1.17	Shift Operator I
e – Maintenance of comminutors	0.53	0.39	0.33	0.31	0.28	Shift Operator II
f – Housekeeping	1.08	1.09	1.10	1.11	1.12	Helper
g – Sampling for lab tests	0.33	0.33	0.33	0.33	0.33	Shift Operator II
h – Other maintenance	0.01	0.05	0.08	0.12	0.15	Helper
Unit process: grit removal						
a – Hand cleaning grit chambers	0.08	0.06	0.05	0.04	0.04	Helper
b – Housekeeping	3.50	3.50	3.50	3.50	3.50	Helper
Unit process: activated sludge tasks						
a – Inspection of equipment	0.75	0.82	0.85	0.87	0.88	Shift Operator II
b – Return pump maintenance	0.28	0.32	0.34	0.36	0.37	Operator I
c – Aerator or blower maintenance	0.12	0.12	0.11	0.11	0.11	Operator II
d – Cleaning air diffusers	0.77	0.80	0.83	0.83	0.84	Helper
e – Other electrical maintenance	0.50	0.15	0.08	0.06	0.04	Operator I

Table I-6. Continued.

Activated sludge system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	Minimum required occupational level
f – Other mechanical maintenance	0.32	0.32	0.32	0.32	0.32	Operator I
g – Return sludge – rate adjustment	0.49	0.18	0.12	0.08	0.07	Operator II
h – Aeration rate adjustment	0.31	0.39	0.43	0.47	0.49	Operator II
i – Sludge removal	1.07	0.43	0.28	0.22	0.18	Operator II
j – Disposal of sludge	2.20	2.13	2.07	2.03	2.00	Operator II
k – Record keeping – reports	0.15	0.53	0.92	1.33	1.75	Shift Operator II
l – Housekeeping	3.00	3.92	4.42	4.83	5.07	Helper
m – Other maintenance	0.07	0.07	0.07	0.08	0.08	Helper
n – Other operation	1.10	0.19	0.09	0.05	0.03	Helper
Unit process: final settling tank						
a – Inspection of mechanical equipment	1.03	1.33	1.50	1.62	1.77	Shift Operator II
b – Maintenance of mechanical equipment	0.33	0.08	0.04	0.02	0.02	Shift Operator II
c – Other general maintenance	0.06	0.05	0.04	0.04	0.03	Shift Operator II
d – Inspection of process – adjust flow	0.43	0.55	0.62	0.66	0.70	Operator I
e – Scum removal	1.32	1.52	1.63	1.70	1.78	Helper
f – Cleaning scum removal equipment	1.17	1.50	1.67	1.82	1.92	Helper
g – Cleaning baffles-weirs	1.17	1.70	2.08	2.33	2.53	Helper
h – Raw sludge pumping	2.33	2.87	3.13	3.33	3.52	Shift Operator II
i – Housekeeping	0.83	1.33	1.63	1.92	2.15	Helper
j – Other operation	0.08	0.23	0.38	0.52	0.67	Helper
Unit process: laboratory control						
a – Settleable	0.83	0.95	1.02	1.05	1.08	Shift Operator II
b – Sludge solids	1.27	0.25	0.12	0.08	0.05	Operator I
c – BOD	0.37	0.33	0.32	0.31	0.30	Operator II
d – pH	0.42	0.88	1.25	1.58	1.87	Operator I

Table I-6. Continued.

Activated sludge system	Average time required/week (by avg. design flow, MGD) 0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0	Minimum required occupational level
e – Grease	1.50	1.13	0.97	0.88	0.83	Operator II
f – Dissolved oxygen	0.83	0.63	0.55	0.50	0.47	Operator I
g – Relative stability	2.97	3.45	3.75	3.87	4.00	Shift Operator II
h – Weather	1.02	0.80	0.72	0.67	0.63	Shift Operator II
i – Sludge volume or sludge density index	0.53	0.38	0.33	0.29	0.27	Operator II
j – Dishwashing	1.93	2.38	2.67	2.83	3.00	Helper
k – Record keeping	3.00	7.17	10.80	14.20	18.30	Operator I
l – Housekeeping	0.62	0.90	1.08	1.23	1.33	Helper
Unit process: miscellaneous tasks						
a – Maintenance of control system	–	3.17	0.50	0.13	0.06	Operator II
b – Maintenance checks	0.06	0.38	0.90	1.58	2.33	Operator I
c – Pump lubrication	0.03	0.22	0.50	0.90	1.37	Shift Operator II
d – Pump packing	–	–	0.08	0.30	0.75	Shift Operator II
e – Grounds keeping	6.85	7.50	7.67	7.83	8.00	Helper

Note: For tasks not included, use time estimates from primary sedimentation systems as an approximation.

4. SAMPLE CALCULATION OF STAFFING REQUIREMENTS USING THE GUIDELINES

Worksheets to be used in computing the staffing guidelines presented in the previous section are shown on the following pages. The examples presented are plants currently in operation and the tasks identified are those currently defined as required of operating personnel at these plants. These examples include a Type 1 basic plant with an average flow of 0.7 MGD, a Type 2 facility with 0.1 MGD average flow, and a Type 3 plant with an average daily flow of 0.3 MGD.

Each sheet is preceded by a summary sheet indicating the processes and the general tasks that are performed. It should be noted that for the Type 3 facility there were grounds keeping requirements, supervision requirements, and some laboratory testing requirements which were not included in the data base for Type 3 facilities. These data were not included due to insufficient information from these facilities from which to construct the necessary time estimates.

In this case the data from Type 1 plants, which had the most complete data base, were used to provide time factors. While there may be differences in the estimates and actual between the two basic types, the error of omission from the time requirement would be greater than the differences in the estimates.

Example 1:

Average flow: 0.7 MGD

Liquid treatment

Raw wastewater pumping (sewer line inspection and maintenance excluded)
Preliminary treatment
Primary sedimentation
Trickling filters
Final sedimentation

Sludge treatment

Primary sludge pumping
Sludge holding tanks
Wet hauling and landfill disposal

Other

Yardwork
Laboratory
General supervision

Staffing	Hour/week estimates from guidelines
Opr. II	1.4
Opr. I	10.6
Shift Opr. II	15.5
Shift Opr. I	2.5
Helper	36.0
Avg. Req'd Hours/wk	66.0

STAFFING REQUIREMENT WORKSHEET (page 1)

Avg. daily flow: 0.7 MGD
Location: Cl, Iowa

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: sewer and lift station maintenance					
Task a – Inspection of sewers and lift stations					
b – Maintenance of sewer lines					
c – Maintenance of lift pumps					2.3
d – Other maintenance					0.5
e – Other operation					
Unit process: screening or comminuting					
a – Hand cleaning of screens					2.3
b – Removal of debris (screenings)					0.5
c – Disposal of debris (screenings)				1.1	
d – Comminutor cleaning					
e – Maintenance of screens				0.2	
f – Maintenance of comminutor					
g – Housekeeping					
h – Sampling for lab tests					0.1
i – Other maintenance					1.2
j – Other operation					
Unit process: grit removal					
a – Hand cleaning grit chambers					
b – Mechanical grit removal					
c – Maintenance of equipment					
d – Housekeeping					
e – Other maintenance					
f – Other operation					

STAFFING REQUIREMENT WORKSHEET (page 2)

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: primary settling tank					
a – Inspection of mechanical equipment			0.8		
b – Maintenance of mechanical equipment			0.4		
c – Other general maintenance					0.3
d – Inspection of process-adjust flow		1.1			
e – Scum removal					2.0
f – Cleaning scum removal equipment					1.4
g – Cleaning baffles-weirs					0.4
h – Sludge collection					
i – Raw sludge pumping				0.8	
j – Housekeeping					1.3
k – Sampling for lab tests					0.3
l – Other maintenance					0.3
m – Other operation					
Unit process: sludge digestion					
a – Temperature control and boiler operation					
b – Boiler maintenance	0.3				
c – Check sludge, water, gas lines					
d – Maintenance of sludge, water, gas lines		0.2			
e – Maintenance of sludge mixing equipment		0.3			
f – Maintenance of pumps		0.4			
g – Other mechanical maintenance			1.3		
h – Sludge pumping					
i – Scum control					
j – Sludge conditioning					
k – Gas collection and control (inc. drip trap empty			0.6		

STAFFING REQUIREMENT WORKSHEET (page 3)

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
l – Withdrawal of supernatant			1.3		
m – Withdrawal of digested sludge			1.4		
n – Sampling for lab tests					0.4
o – Housekeeping					0.4
p – Other maintenance					0.2
q – Other operation					
Unit process: digested sludge dewatering and disposal					
a – Wet hauling sludge					3.0
b – Lagooning					
c – Landfill					0.5
d – Other maintenance					
Unit process: trickling filter tasks					
a – Pump maintenance					
b – Maintenance of tanks					
c – Other electrical maintenance					
d – Other mechanical maintenance			0.3		
e – Cleaning arms					1.5
f – Cleaning under drains					
g – Cleaning tanks					0.3
h – Inspection – flow adjustment		0.2			
i – Filter fly control					
j – Ice control			4.2		
k – Other maintenance					0.2
l – Other operation					0.2

STAFFING REQUIREMENT WORKSHEET (page 4)

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: final settling tank					
a – Inspection of mechanical equipment					
b – Maintenance of mechanical equipment			0.3		
c – Other general maintenance				0.4	
d – Inspection of process-adjust flow					
e – Scum removal					
f – Cleaning scum removal equipment					
g – Cleaning baffles-weirs					2.1
h – Sludge collection					
i – Raw sludge pumping					
j – Housekeeping					
k – Sampling for lab tests					
l – Other maintenance					
m – Other operation					
Unit process: laboratory control					
a – Total		0.5			
b – Suspended		0.8			
c – Settleable			1.4		
d – Volatile solids		0.8			
e – Sludge solids		0.4			
f – BOD	1.1				
g – pH		1.2			
h – Dissolved oxygen			0.8		
i – Relative stability			1.3		
j – Weather					
k – Volatile acids			1.3		
l – Sludge volume or sludge density index					2.2

STAFFING REQUIREMENT WORKSHEET (page 5)

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
m – Dishwashing					
n – Record keeping		4.6			1.3
o – Lab maintenance					0.3
p – Housekeeping					0.2
q – Other maintenance					
r – Other operation					
Unit process: miscellaneous tasks					
a – Maintenance of control system					
b – Maintenance checks					
c – Pump lubrication			0.03		
d – Pump packing			0.1		
e – Planning					
f – Supervision					
g – Training					7.8
h – Housekeeping					
i – Grounds keeping					
j – Safety equipment maintenance		0.1			
k – Ventilation equipment maintenance					
l – Chlorination					
m – Sampling of flow					0.2
n – Other maintenance					0.3
o – Other operation	—	—	—	—	
Total hours/week	1.4	10.6	15.5	2.5	36.0

STAFFING REQUIREMENT WORKSHEET (page 1)

Avg. daily flow: _____
Location: _____

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: sewer and lift station maintenance					
Task a – Inspection of sewers and lift stations					
b – Maintenance of sewer lines					
c – Mainteinance of lift pumps					
d – Other maintenance					
e – Other operation					
Unit process: screening or comminuting					
a – Hand cleaning of screens					
b – Removal of debris (screenings)					
c – Disposal of debris (screenings)					
d – Comminutor cleaning					
e – Maintenance of screens					
f – Maintenance of comminutor					
g – Housekeeping					
h – Sampling for lab tests					
i – Other maintenance					
j – Other operation					
Unit process: grit removal					
a – Hand cleaning grit chambers					
b – Mechanical grit removal					
c – Maintenance of equipment					
d – Housekeeping					
e – Other maintenance					
f – Other operation					

STAFFING REQUIREMENT WORKSHEET (page 2)

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: primary settling tank					
a – Inspection of mechanical equipment					
b – Maintenance of mechanical equipment					
c – Other general maintenance					
d – Inspection of process-adjust flow					
e – Scum removal					
f – Cleaning scum removal equipment					
g – Cleaning baffles-weirs					
h – Sludge collection					
i – Raw sludge pumping					
j – Housekeeping					
k – Sampling for lab tests					
l – Other maintenance					
m – Other operation					
Unit process: sludge digestion					
a – Temperature control and boiler operation					
b – Boiler maintenance					
c – Check sludge, water, gas lines					
d – Maintenance of sludge, water, gas lines					
e – Maintenance of sludge mixing equipment					
f – Maintenance of pumps					
g – Other mechanical maintenance					
h – Sludge pumping					
i – Scum control					
j – Sludge conditioning					
k – Gas collection and control (inc. drip trap empty)					

STAFFING REQUIREMENT WORKSHEET (page 3)

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
l – Withdrawal of supernatant					
m – Withdrawal of digested sludge					
n – Sampling for lab tests					
o – Housekeeping					
p – Other maintenance					
q – Other operation					
Unit process: digested sludge dewatering and disposal					
a – Wet hauling sludge					
b – Lagooning					
c – Landfill					
d – Other maintenance					
Unit process: trickling filter tasks					
a – Pump maintenance					
b – Maintenance of tanks					
c – Other electrical maintenance					
d – Other mechanical maintenance					
e – Cleaning arms					
f – Cleaning under drains					
g – Cleaning tanks					
h – Inspection – flow adjustment					
i – Filter fly control					
j – Ice control					
k – Other maintenance					
l – Other operation					

STAFFING REQUIREMENT WORKSHEET (page 4)

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: final settling tank					
a – Inspection of mechanical equipment					
b – Maintenance of mechanical equipment					
c – Other general maintenance					
d – Inspection of process-adjust flow					
e – Scum removal					
f – Cleaning scum removal equipment					
g – Cleaning baffles-weirs					
h – Sludge collection					
i – Raw sludge pumping					
j – Housekeeping					
k – Sampling for lab tests					
l – Other maintenance					
m – Other operation					
Unit process: laboratory control					
a – Total					
b – Suspended					
c – Settleable					
d – Volatile solids					
e – Sludge solids					
f – BOD					
g – pH					
h – Dissolved oxygen					
i – Relative stability					
j – Weather					
k – Volatile acids					
l – Sludge volume or sludge density index					

STAFFING REQUIREMENT WORKSHEET (page 5)

Primary sedimentation system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
m – Dishwashing					
n – Record keeping					
o – Lab maintenance					
p – Housekeeping					
q – Other maintenance					
r – Other operation					
Unit process: miscellaneous tasks					
a – Maintenance of control system					
b – Maintenance checks					
c – Pump lubrication					
d – Pump packing					
e – Planning					
f – Supervision					
g – Training					
h – Housekeeping					
i – Grounds keeping					
j – Safety equipment maintenance					
k – Ventilation equipment maintenance					
l – Chlorination					
m – Sampling of flow					
n – Other maintenance					
o – Other operation					
Total hours/week	___	___	___	___	___

Example 2:

Average flow: 0.1 MGD

Liquid treatment

Raw wastewater pumping (sewer line maintenance excluded)
Preliminary treatment (screening)
Trickling filter
Final sedimentation

Sludge treatment

Imhoff tank
Landfill disposal

Other

Supervision
Laboratory
Yardwork

Staffing	Hour/week estimates from guidelines
Opr. II	–
Opr. I	5.6
Shift Opr. II	9.9
Shift Opr. I	1.2
Helper	15.2
Average required hours/week	31.9

STAFFING REQUIREMENT WORKSHEET (page 1)

Avg. daily flow: 0.1 MGD
Location: Co, Iowa

Imhoff tank system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: sewer and lift stations maintenance					
a – Inspection of sewers and lift stations			4.0		
b – Maintenance of sewer lines					
c – Maintenance of lift pumps			0.7		
Unit process: screening or comminuting tasks					
a – Hand cleaning of screens					1.9
b – Removal of debris (screenings)					
c – Disposal of debris (screenings)					
d – Housekeeping					0.7
e – Sampling for lab tests					
f – Other maintenance					
Unit process: Imhoff tanks					
a – Inspection and flow adjustment					
b – Maintenance of equipment					
c – Squeegeeing the walls					0.9
d – Scum removal					1.8
e – Cleaning the slot					0.8
f – Sludge removal				0.3	
g – Measuring sludge depth			0.2		
h – Other maintenance					0.4
i – Other operation					1.2
Unit process: digested sludge dewatering and disposal					
a – Wet hauling sludge					
b – Landfill				0.9	

STAFFING REQUIREMENT WORKSHEET (page 2)

Imhoff tank system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: trickling filter tasks					
a – Pump maintenance					
b – Maintenance of tanks					1.7
c – Cleaning arms					0.7
d – Cleaning under drains					
e – Cleaning tanks					
f – Filter fly control					
g – Ice control					
h – Other maintenance					
i – Other operation					
Unit process: final settling tanks					
a – Inspection of mechanical equipment					
b – Maintenance of mechanical equipment			0.1		
c – Scum removal					0.1
d – Cleaning baffles-weirs					1.3
e – Sludge collection					
f – Raw sludge pumping			1.0		
g – Housekeeping					
h – Sampling for lab tests			0.2		
Unit process: laboratory control					
a – Settleable			1.8		
b – BOD					
c – pH		1.1			
d – Dissolved oxygen		0.7			
e – Relative stability			1.1		
f – Weather			0.8		

STAFFING REQUIREMENT WORKSHEET (page 3)

Imhoff tank system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
g – Dishwashing					
h – Record keeping					
i – Lab maintenance					0.2
j – Housekeeping					
k – Other operation					
Unit process: miscellaneous tasks					
a – Planning					
b – Supervision		3.8			
c – Housekeeping					0.8
d – Grounds keeping					2.7
e – Other maintenance	—	—	—	—	—
Total hours/week		5.6	9.9	1.2	15.2

STAFFING REQUIREMENT WORKSHEET (page 1)

Avg. daily flow: _____
Location: _____

Imhoff tank system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: sewer and lift stations maintenance					
a – Inspection of sewers and lift stations					
b – Maintenance of sewer lines					
c – Maintenance of lift pumps					
Unit process: screening or comminuting tasks					
a – Hand cleaning of screens					
b – Removal of debris (screenings)					
c – Disposal of debris (screenings)					
d – Housekeeping					
e – Sampling for lab tests					
f – Other maintenance					
Unit process: Imhoff tanks					
a – Inspection and flow adjustment					
b – Maintenance of equipment					
c – Squeegeeing the walls					
d – Scum removal					
e – Cleaning the slot					
f – Sludge removal					
g – Measuring sludge depth					
h – Other maintenance					
i – Other operation					
Unit process: digested sludge dewatering and disposal					
a – Wet hauling sludge					
b – Landfill					

STAFFING REQUIREMENT WORKSHEET (page 2)

Imhoff tank system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: trickling filter tasks					
a – Pump maintenance					
b – Maintenance of tanks					
c – Cleaning arms					
d – Cleaning under drains					
e – Cleaning tanks					
f – Filter fly control					
g – Ice control					
h – Other maintenance					
i – Other operation					
Unit process: final settling tanks					
a – Inspection of mechanical equipment					
b – Maintenance of mechanical equipment					
c – Scum removal					
d – Cleaning baffles-weirs					
e – Sludge collection					
f – Raw sludge pumping					
g – Housekeeping					
h – Sampling for lab tests					
Unit process: laboratory control					
a – Settleable					
b – BOD					
c – pH					
d – Dissolved oxygen					
e – Relative stability					
f – Weather					

STAFFING REQUIREMENT WORKSHEET (page 3)

Imhoff tank system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
g – Dishwashing					
h – Record keeping					
i – Lab maintenance					
j – Housekeeping					
k – Other operation					
Unit process: miscellaneous tasks					
a – Planning					
b – Supervision					
c – Housekeeping					
d – Grounds keeping					
e – Other maintenance					
Total hours/week	___	___	___	___	___

Example 3:

Average flow: 0.3 MGD

Liquid treatment

Raw wastewater pumping (sewer line inspection and maintenance excluded)
Preliminary treatment
Aeration
Final sedimentation

Sludge treatment

Primary sludge pumping
Sludge digestion

Other

Supervision
Yardwork
Laboratory

Staffing	Hour/week estimates from guidelines
Opr. II	4.0
Opr. I	12.1
Shift Opr. II	4.5
Shift Opr. I	0.8
Helper	15.9
Average required hours/week	37.3

STAFFING REQUIREMENT WORKSHEET (page 1)

Avg. daily flow: 0.3 MGD
Location: H, Iowa

Activated sludge system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: sewer and lift station maintenance					
a – Inspection of sewers and lift stations					
b – Maintenance of lift pumps			0.2		
c – Other maintenance					
Unit process: screening or comminuting tasks					
a – Hand cleaning of screens					0.3
b – Removal of debris (screenings)					0.5
c – Disposal of debris (screenings)				0.8	
d – Comminutor cleaning					
e – Maintenance of comminutors			0.4		
f – Housekeeping					1.1
g – Sampling for lab tests					0.1
h – Other maintenance					
Unit process: grit removal					
a – Hand cleaning grit chambers					
b – Housekeeping					
Unit process: activated sludge tasks					
a – Inspection of equipment					
b – Return pump maintenance		0.3			
c – Aerator or blower maintenance	0.1				0.9
d – Cleaning air diffusers					
e – Other electrical maintenance					

STAFFING REQUIREMENT WORKSHEET (page 2)

Activated sludge system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
f – Other mechanical maintenance					
g – Return sludge – rate adjustment	0.5				
h – Aeration rate adjustment	0.3				
i – Sludge removal	0.4				
j – Disposal of sludge	2.1				
k – Record keeping – reports					
l – Housekeeping					0.1
m – Other maintenance					
n – Other operation					
Unit process: final settling tank					
a – Inspection of mechanical equipment					
b – Maintenance of mechanical equipment					
c – Other general maintenance					
d – Inspection of process – adjust flow		0.6			
e – Scum removal					1.5
f – Cleaning scum removal equipment					1.5
g – Cleaning baffles-weirs					
h – Raw sludge pumping			2.9		
i – Housekeeping					
j – Other operation					
Unit process: laboratory control					
Total and suspended solids					
a – Settleable		1.9			
b – Sludge solids			1.0		
c – BOD	0.3	0.3			
d – pH		0.9			
e – Grease					

STAFFING REQUIREMENT WORKSHEET (page 3)

Activated sludge system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
f – Dissolved oxygen		0.6			
g – Relative stability					
h – Weather					
i – Sludge volume or sludge density index	0.4				
j – Dishwashing					2.4
k – Record keeping		3.0			
l – Housekeeping					
Unit process: miscellaneous tasks					
a – Maintenance of control system					
b – Maintenance checks					
c – Pump lubrication					
d – Pump packing					
e – Supervision		4.5			
f – Grounds keeping	—	—	—	—	7.5
Total hours/week	4.0	12.1	4.5	0.8	15.9

STAFFING REQUIREMENT WORKSHEET (page 1)

Avg. daily flow: _____
Location: _____

Activated sludge system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
Unit process: sewer and lift station maintenance					
a – Inspection of sewers and lift stations					
b – Maintenance of lift pumps					
c – Other maintenance					
Unit process: screening or comminuting tasks					
a – Hand cleaning of screens					
b – Removal of debris (screenings)					
c – Disposal of debris (screenings)					
d – Comminutor cleaning					
e – Maintenance of comminutors					
f – Housekeeping					
g – Sampling for lab tests					
h – Other maintenance					
Unit process: grit removal					
a – Hand cleaning grit chambers					
b – Housekeeping					
Unit process: activated sludge tasks					
a – Inspection of equipment					
b – Return pump maintenance					
c – Aerator or blower maintenance					
d – Cleaning air diffusers					
e – Other electrical maintenance					

STAFFING REQUIREMENT WORKSHEET (page 2)

Activated sludge system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
f – Other mechanical maintenance					
g – Return sludge – rate adjustment					
h – Aeration rate adjustment					
i – Sludge removal					
j – Disposal of sludge					
k – Record keeping – reports					
l – Housekeeping					
m – Other maintenance					
n – Other operation					
Unit process: final settling tank					
a – Inspection of mechanical equipment					
b – Maintenance of mechanical equipment					
c – Other general maintenance					
d – Inspection of process – adjust flow					
e – Scum removal					
f – Cleaning scum removal equipment					
g – Cleaning baffles-weirs					
h – Raw sludge pumping					
i – Housekeeping					
j – Other operation					
Unit process: laboratory control Total and suspended solids					
a – Settleable					
b – Sludge solids					
c – BOD					
d – pH					
e – Grease					

STAFFING REQUIREMENT WORKSHEET (page 3)

Activated sludge system	Operator II (SWTP)	Operator I (SWTP)	Shift opr. II	Shift opr. I	Helper
f – Dissolved oxygen					
g – Relative stability					
h – Weather					
i – Sludge volume or sludge density index					
j – Dishwashing					
k – Record keeping					
l – Housekeeping					
Unit process: miscellaneous tasks					
a – Maintenance of control system					
b – Maintenance checks					
c – Pump lubrication					
d – Pump packing					
e – Supervision					
f – Grounds keeping					
Total hours/week	___	___	___	___	___

5. SAMPLE STAFFING PATTERNS

The previous examples represented the application of guidelines for selected locations where the tasks were identified uniquely to the selected facility. However the largest requirement in hr/wk would result from other task combinations. At the extreme, facilities which would require all of the tasks identified in the guidelines would require the maximum staffing hours per week. Where tasks other than those identified are required, the time requirement would increase accordingly. However, most plants will require fewer personnel than indicated since it is not common for all of the identified tasks to be required at a given plant.

In all cases, there are more occupations than positions. For the small plant management, this implies that the highest qualification level should be the basis for hiring for at least one of the positions. However, the candidates must be expected to spend portions of his time in lower level occupations in order to perform all of the required tasks. A wage scale should be established for each occupation based on best principles of wage determination and the position paid in proportion to the time required in each occupation.

Further development of the time estimates to other unit processes or to tasks not included in the study on which these guidelines are based is recommended for future studies.

SAMPLE STAFFING PATTERNS — PRIMARY SEDIMENTATION SYSTEM

Maximum Staff Levels Based on 40-Hour Work Week

	Average daily design flow, MGD				
	0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0
Operator II	1.95	1.90	2.53	3.27	4.76
Operator I	16.24	18.60	23.74	31.00	38.12
Shift Operator II	16.19	21.39	26.80	33.24	46.10
Shift Operator I	12.87	15.77	17.54	19.81	20.83
Helper	40.70	40.72	48.77	52.59	56.85
Total hr/wk	87.95	98.38	119.38	139.91	166.66
No. of personnel	2.19	2.45	2.98	3.49	4.16

Facility descriptions:

a) Lift station at the facility with some sewer line inspection and maintenance required

b) Screening devices including bar screens and/or comminutors

c) Grit chambers both hand and mechanically cleaned

d) Primary sedimentation tanks, usually with mechanical cleaning equipment but occasionally with hopper bottom tanks

e) Separate heated or unheated sludge digestion (occasional filtering of raw sludge for land fill disposal)

f) Trickling filter, usually circular, with rotary distributor with some fixed nozzle filters

g) Final sedimentation in either mechanically cleaned or hopper bottom sedimentation settling tanks

h) Sludge from final sedimentation tanks returned by gravity to the lift station wet well or pumped to the influent if lift station not provided

i) Digested sludge either dried on sand drying beds or wet hauled to agricultural land

j) Laboratory control, supervision of process and personnel, yard-work included

SAMPLE STAFFING PATTERNS - IMHOFF TANK SYSTEM

Maximum Staff Levels Based on 40-Hour Work Week*

	Average daily design flow, MGD		
	0-0.2	0.2-0.4	0.4-0.6
Operator II	0.86	1.42	2.23
Operator I	16.68	17.78	20.72
Shift Operator II	16.46	13.91	13.79
Shift Operator I	1.31	1.83	5.19
Helper	27.02	32.43	48.44
Total hr/wk	62.33	67.37	90.37
No. of personnel	1.56	1.68	2.26

Facility descriptions:

a) Lift station or gravity flow with some sewer line inspection and maintenance required

b) Screening usually by hand cleaned bar screen

c) Grit chamber usually hand cleaned

d) Rectangular or circular Imhoff tank

e) Trickling filter with rotary distributor

f) Final sedimentation usually with a hopper bottom

g) Sludge return from final sedimentation by gravity to wet well of the pumping station or by lift pump to the plant influent

h) Sand drying beds for digested sludge with disposal on agricultural land or in landfill

i) Supervision of process and personnel, yardwork, and laboratory control included

*Includes laboratory and miscellaneous task estimates from primary sedimentation systems when missing from the Imhoff tank systems.

SAMPLE STAFFING PATTERNS – ACTIVATED SLUDGE SYSTEM

Maximum Staff Levels Based on 40-Hour Work Week*

	Average daily design flow, MGD				
	0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0
Operator II	7.44	9.48	6.60	6.25	6.41
Operator I	17.28	20.19	25.81	34.11	46.24
Shift Operator II	12.68	13.50	14.74	16.08	17.79
Shift Operator I	0.52	0.77	0.93	1.05	1.17
Helper	28.00	31.76	34.72	37.22	39.32
Total hr/wk	65.92	75.70	82.80	94.71	110.93
No. of personnel	1.65	1.89	2.07	2.38	2.77

Facility descriptions:

a) Lift station with raw wastewater flow going into aeration tanks

b) Bar screen or comminutors. Grit chambers usually not included

c) Activated sludge process using either extended aeration or contact stabilization

d) Diffused aeration with positive displacement blowers most commonly used

e) Final sedimentation tanks with scum baffles; tanks with hopper bottoms or mechanical sludge and scum removal

f) Air lift pumps used to return sludge to aeration tanks

g) Facilities frequently followed by small polishing lagoons

h) Facilities occasionally equipped with aerobic digestors and sludge holding tanks

*Includes laboratory and miscellaneous task estimates from primary sedimentation systems when missing from the activated sludge systems.

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APPENDIX I-A: DESCRIPTION OF APTITUDES, INTERESTS, TEMPERAMENTS, PHYSICAL DEMAND, WORKING CONDITIONS*

Aptitudes are defined as the specific capacities or abilities required of an individual in order to facilitate the learning of some task or job duty. The amounts are expressed in terms of levels which in turn reflect equivalent amounts of the aptitudes possessed by segments of the working population, as follows:

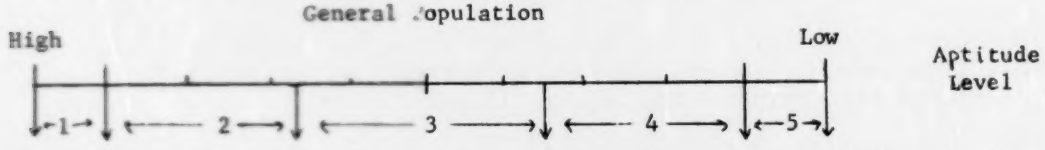
1. The top 10 percent of the population. This segment of the population possesses an extremely high degree of the aptitude.

2. The highest third exclusive of the top 10 percent of the population. This segment of the population possesses an above average of high degree of the aptitude.

3. The middle third of the population. This segment of the population possesses a medium degree of the aptitude ranging from slightly below to slightly above average.

4. The lowest third exclusive of the bottom 10 percent of the population. This segment of the population possesses a below average or low degree of the aptitude.

5. The lowest 10 percent of the population. This segment of the population possesses a negligible degree of the aptitude.



Aptitudes defined:

1. Intelligence – General learning ability. The ability to "catch on" or understand instructions and underlying principles: the ability to reason and make judgments. Closely related to doing well in school.

2. Verbal Aptitude – The ability to understand meaning of words and to use them effectively. The ability to comprehend language, to understand relationships between words and to understand meanings of whole sentences and paragraphs.

3. Numerical Apcitude – The ability to perform arithmetic operations quickly and accurately.

4. Spatial Aptitude – Ability to think visually of geometric forms and to comprehend the two-dimensional representation of three-dimensional objects. The ability to recognize the relationships resulting from the movements of objects in space.

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*Descriptions and explanations obtained in Handbook for Analyzing Jobs, U.S. Department of Labor, Manpower Administration (1972).

5. Form Perception – Ability to perceive pertinent detail in objects or in pictorial or graphic material. Ability to make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines.

6. Clerical Perception – Ability to perceive pertinent detail in verbal or tubular material. Ability to observe differences in copy, to proof-read words and numbers, and to avoid perceptual errors in arithmetic computation. A measure of speed of perception is required in many industrial jobs even when the job does not have verbal or numerical content.

7. Motor Coordination – Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make movement response accurately and swiftly.

8. Finger Dexterity – Ability to move fingers, and manipulate small objects with fingers, rapidly or accurately.

9. Manual Dexterity – Ability to move hands easily and skillfully. To work with hands in placing and turning motions.

10. Eye-Hand-Foot Coordination – Ability to move the hand and foot coordinately with each other in accordance with visual stimuli.

11. Color Discrimination – The ability to match or discriminate between colors in terms of hue, saturation and brilliance. To identify a particular color or color combination from memory and be able to perceive harmonious or contrasting color combinations.

12. Temperaments – the "personal traits" required of a worker by specific job-worker situations.

13. Interests – preferences for certain types of work activities or experiences, with accompanying rejection of contrary types of activities or experiences.

14. Physical Demands – the physical requirements made of the worker by the specific job-worker situation.

15. Working Conditions – the physical surroundings of job-worker situations which make specific demands upon a worker's physical capacity.

APPENDIX I-B:

GLOSSARY

Biochemical oxygen demand – the quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specified temperature, and under specified conditions. This term also refers to a standard test used in assessing wastewater strength.

Biochemical oxygen demand, standard – biochemical oxygen demand as determined under standard laboratory procedure for five days at 20 ^{o}C, usually expressed in parts per million.

Certification – the granting of a certificate which states than an individual has successfully completed a given course or a series of related courses and indicating that the individual is qualified to perform a given function.

Effluent – 1) a liquid which flows out of a containing space, 2) wastewater, water, or other liquid, partially or completely treated, or in its natural state, as the case may be, flowing out of a reservoir, basin, or treatment plant, or part thereof.

Final – the effluent from the final unit of a wastewater treatment plant.

Stable – a treated wastewater which contains enough oxygen to satisfy its oxygen demand.

Feedback – making available to a program the results of monitoring and evaluation so that the program can be continuously improved.

Fringe benefits – those nonmonetary rewards or benefits provided by an employer.

General educational development – embraces those aspects of education (formal and informal) which contribute to the worker's: (1) reasoning development and ability to follow instructions, and (2) acquisition of "tool" knowledge, such as language and mathematical skills.

General education development diploma (GED) – a program designed for school dropouts to give them the development equivalent to that received from securing a high school diploma, and generally accepted in lieu of that diploma.

Grease – in wastewater, grease including fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and other non-fatty materials. The type of solvent used for its extraction should be stated.

Grit – the heavy mineral matter in water or wastewater, such as gravel, cinders, etc.

Human resource development – the development of human beings into producers through education, training, and employment services.

Index, sludge volume – the volume is milliliters occupied by one gram of dry solids after the aerated mixed liquor settles 30 minutes, commonly referred to as the Mohlman index.

Interests – preferences for certain types of work activities or experiences, with accompanying rejection of contrary types of activities or experiences.

Job assignment – a group of work tasks assigned to one employee.

Job demands – the abilities, personal traits, and individual characteristics required of the employee to adequately perform the job assignment.

Job design – the act of determining which specific work tasks will be grouped together and considered as a work unit for assignment to one individual.

Job description – a general statement about the tasks which comprise the job being described including: a) what actions are to be performed; b) accomplishments expected by these actions; c) tools and/or equipment to be used/ and d) the degree of discretion the job holder has in determining when actions are to be taken.

Job evaluation – the process of dividing a job into its major components to enable analysis for the purpose of establishing rates of pay and training.

Job specification – a statement identifying those abilities, personal traits, and individual characteristics required of a worker in order to achieve average-successful job performance on the job specified.

Labor market – the geographical area within which most workers are secured. For some occupations, this may be a given community, while for others it may be nationwide.

Macro-manpower planning – that manpower planning associated with macro-economic planning, which generally involves full employment of human resources of manpower.

Manpower planning – the planning process directed to ensuring the right number of the right types of people are available at the right time in order to accomplish most economically the task or function at hand.

Micro-manpower planning – that manpower planning involved in meeting the manpower needs of a particular company, agency or industry.

National manpower program planning – that manpower planning involved in meeting specific national needs, i.e., pollution, disadvantaged, shortage of science skills, etc.

Occupational cluster – a grouping of closely related skills or occupations having a common core of skills and/or learning.

Occupation description – a description of job duties, responsibilities, and prerequisite qualifications related to a specific occupation title, and developed in conformance with the Dictionary of Occupational Title, published by the United States Department of Labor.

Occupation title – the title denoting a specific occupation description.

On-the-job training (OJT) – the usually informal training that is a part of learning a job as compared with classroom and apprenticeship programs.

Oxygen – a chemical element

- Available – the quantity of uncombined or free oxygen dissolved in the water of a stream
- Balance – the relation between the biochemical oxygen demand of a wastewater or treatment plant effluent and the oxygen available in the diluting water
- Consumed – the quantity of oxygen taken from potassium permanganate in solution by a liquid containing organic matter. Commonly regarded as an index of the carbonaceous matter present. Time and temperature must be specified. The chemical oxygen demand (COD) uses potassium dichromate.
- Deficiency – the additional quantity of oxygen required to satisfy the biochemical oxygen demand in a given liquid. Usually expressed in parts per million.
- Dissolved – usually designated as DO. The oxygen dissolved in wastewater, water or other liquid usually expressed in parts per million or percentage of saturation.
- Residual – the dissolved oxygen content of a stream after deoxygenation has begun.

pH – the logarithm of the reciprocal of the hydrogen-ion concentration. It is not the same as the alkalinity and cannot be calculated therefrom.

Physical demands – the physical requirements made of the worker by the specific job-worker situation.

Pollution – a condition created by the presence of harmful or objectionable material in water.

Process – a sequence of operations.

Activated sludge – a biological wastewater treatment process in which a mixture of wastewater and activated sludge is agitated and aerated. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation, and wasted or returned to the process as needed. The treated wastewater overflows the weir of the settling tank in which separation from the sludge takes place.

Biological – the process by which the lift activities of bacteria, and other microorganisms in the search for food, break down complex organic materials into simple, more stable substances. Self-purification of wastewater-polluted streams, sludge digestion, and all so-called secondary wastewater treatments result from this process. Also called Biochemical Process.

Productivity – the output per unit of input, usually per person or per man-hour.

Promotion – the movement up an occupational ladder.

Public employment – employment with a government agency.

Salary – payment by the week, month, or year.

Sludge – the accumulated settled solids deposited from wastewater or industrial wastes, raw or treated, in tanks or basins, and containing more or less water to form a semiliquid mass.

Activated – sludge floc produced in raw or settled wastewater by the growth of zoogloeal bacteria and other organisms in the presence of dissolved oxygen, and accumulated in sufficient concentration by returning floc previously formed.

Conditioning – treatment of liquid sludge preliminary to dewatering and drainability, usually by the addition of chemicals.

Dewatering – the process of removing a part of the water in sludge by any method, such as draining, evaporation, pressing, centrifuging, exhausting, passing between rollers, or acid flotation, with or without heat. It involves reducing from a liquid to a spadable condition rather than merely changing the density of the liquid (concentration) on the one hand or drying (as in a kiln) on the other.

Digester – the process by which organic or volatile matter in sludge is gasified, liquefied, mineralized, or converted into more stable organic matter, through the activities of living organisms.

Solids – material in the solid state.

Dissolved – solids which are present in solution.

Nonsettleable – finely divided suspended solids which will not subside in quiescent water, wastewater, or other liquid in a reasonable period. Such period is commonly, though arbitrarily, taken as two hours.

Settleable – suspended solids which will subside in quiescent water, wastewater, or other liquid in a reasonable period. Such period is commonly, though arbitrarily, taken as one hour. Also called Settling Solids.

Suspended – the quantity of material deposited when a quantity of water, wastewater, or other liquid is filtered through an asbestos mat in a Gooch crucible.

Total – the solids in water, wastewater, or other liquids; it includes the suspended solids (largely removable by filter paper) and the filterable solids (those which pass through filter paper).

Volatile – the quantity of solids in water, wastewater, or other liquid, lost on ignition of the total solids.

Specific vocational preparation – the amount of time required to learn the techniques, acquire information, and develop the facility needed for average performance in a specific job-worker situation. This training may be acquired in a school, work, military, institutional, or a vocational environment.

Stability – the ability of any substance, such as wastewater, effluent, or digested sludge, to resist putrefaction (rotting). It is the antonym of putrescibility.

System effectiveness – the extent to which the system produces an effluent which is socially acceptable. Influencing factors are: the waste or influent; treatment facilities; and job performance.

Tank – a circular or rectangular vessel.

Final settling – a tank through which the effluent from a trickling filter, or aeration or contact aeration tank flows for the purpose of removing the settleable solids.

Imhoff – a deep two-storied wastewater tank originally patented by Karl Imhoff, consisting of an upper or continuous flow sedimentation chamber and a lower or sludge-digestion chamber. The floor of the upper chamber slopes steeply to trapped slots, through which solids may slide into the lower chamber. The lower chamber receives no fresh wastewater directly, but is provided with gas vents and with means for drawing digested sludge from near the bottom.

Primary settling – the first settling tank through which wastewater is passed in a treatment works.

Secondary – a tank following a trickling filter or activated sludge aeration chamber.

Sedimentation – a tank or basin, in which water, wastewater or other liquid containing settleable solids, is retained for

a sufficient time, and in which the velocity of flow is sufficiently low, to remove by gravity a part of the suspended matter. Usually, in wastewater treatment, the detention period is short enough to avoid anaerobic decomposition. Also termed Settling or Subsidence Tank.

Septic – a single-story settling tank in which the settled sludge is in immediate contact with the wastewater flowing through the tank, while the organic solids are decomposed by anaerobic bacterial action.

Task level – the relative complexity or simplicity of a task as expressed on the worker function scales.

Task orientation – the relative involvement of a work with data, people, and things as he performs a given job assignment.

Technical college – a post-high school educational institution which prepares technicians in relatively narrow occupational areas.

Temperaments – the "personal traits" required of a worker by specific job-worker situations.

Thickener, sludge – a type of sedimentation tank in which the sludge is permitted to settle, usually equipped with scrapers traveling along the bottom of the tank which push the settled sludge to a sump, from which it is removed by gravity or by pumping.

Training – the development of vocational skills.

Treatment – any definite process for modifying the state of matter.

Preliminary – the conditioning of an industrial waste at its source prior to discharge, to remove or to neutralize substances injurious to sewers and treatment processes or to effect a partial reduction in load on the treatment process. In the treatment process, unit operations which prepare the liquor for subsequent major operations.

Treatment activities – the different treatment functions, each of which accomplishes a specified end result which contributes to the total wastewater treatment objective.

Turnover – the change of personnel.

Unit process – a classification of portions of the wastewater treatment plant facilities according to their function.

Upgrading – the improvement of job skills.

Vocational education – the preparation of an individual for a vocation, usually requiring manual skills.

Wages – payment by unit of time.

Wastewater – largely the water supply of a community after it has been fouled by various uses. From the standpoint of source it may be a combination of the liquid or water-carried wastes from residences, business buildings, and institutions, together with those from industrial establishments, and with such ground water, surface water, and storm water as may be present.

Domestic – wastewater derived principally from dwellings, business buildings, institutions, and the like. (It may or may not contain ground water, surface water, or storm water.)
Fresh – wastewater of recent origin containing dissolved oxygen at the point of examination.
Industrial – wastewater in which industrial wastes predominate.
Stable – wastewater in which the organic matter has been stablized.
Raw – wastewater prior to receiving any treatment
Sanitary – 1) domestic wastewater with storm and surface water excluded.
2) wastewater discharging from the sanitary conveniences of dwellings (including apartment houses and hotels), office buildings, factories, or institutions.
3) the water supply of a community after it has been used and discharged into a wastewater.
Septic – wastewater undergoing putrefaction under anaerobic conditions.
Settled – wastewater from which most of the settleable solids have been removed by sedimentation.
Stale – a wastewater containing little or no oxygen, but as yet free from putrfaction.

Wastewater treatment – any artificial process to which wastewater is subjected in order to remove or alter its objectional constituents and thus to render it less offensive or dangerous.

Wastewater treatment facilities – the current and given facilities at a treatment location.

Water quality – the chemical, physical, and biological characteristics of water with respect to its suitability for a particular use.

Water standards – definitions of water quality established as a basis for control for various water-use classifications.

Working conditions – the physical surroundings of job-worker situations which make specfic demands upon a worker's physical capacity.

Worker functions – the relationship, in a job-worker situation, on the part of the worker to data, people and things. These relationships are expressed by 24 worker functions arranged in hierarchies, according to level; the lower the identifying number, the higher the level.

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